85th
THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學
Research and Innovation Office
研究及創新事務處

# Science and Engineering Innovations

# Contents

# PolyU's Research and Innovation

PolyU commits to research excellence and addresses global challenges with practical innovation.

Our commitment to interdisciplinary research has led to innovative discoveries for a more sustainable tomorrow. We uncover knowledge and transform research excellence into impactful innovation through multi-disciplinary collaborations.

We open new horizons in space, improve human health and wellbeing, boost economic efficiency and foster sustainability for a better world.




RIO

# Research and Innovation Office

Research and Innovation Office (RIO), as a forward-looking department in the University, is devoted to propelling the University's technology development and advances to benefit the society by providing all-rounded support to facilitate research endeavours within the PolyU community, and foster partnerships among universities, industries, governments, supranational bodies, and the public.

RIO is committed to synergise research capabilities and the transformation of innovation to technology advancement, thus delivering positive impacts to the community. We pursue excellence in managing research grants, developing research and industrial partnership and providing support to the university's key research projects.

**Our Roles**

- Exert all-rounded support to facilitate research endeavours, including the application for funding, both internally and externally.
- Impel translational research across disciplines to provide joint responses to global challenges.
- Engage PolyU experts with industry players to spur high-impact research partnership.
- Build strategic platforms to foster university, industry, and government (UIG) collaboration.

## Supporting Hong Kong as a global hub for research collaboration

PolyU has also been contributing to the long-term growth and prosperity of Hong Kong. The University is particularly pleased to be supporting the Hong Kong Government's important new initiative, InnoHK Clusters, which aims to develop the city into a hub for international research collaboration. By harnessing our research competence in artificial intelligence, design, and vision science, we have partnered with world-leading institutions to develop three research centres under two research clusters – AIR@InnoHK (focusing on artificial intelligence and robotics technologies) and Health@InnoHK (focusing on healthcare-related technologies), in an effort to bring together leading researchers from around the world to conduct impactful collaborative research in Hong Kong.

These three world-class research centres, which have commenced operation at the Hong Kong Science Park, are: the Laboratory for Artificial Intelligence in Design (AiDLab), established in collaboration with the Royal College of Art, UK; the Centre for Advances in Reliability and Safety (CAiRS), established with the University of Maryland, College Mark, USA as the key research collaborator; and the Centre for Eye and Vision Research (CEVR), established in partnership with the University of Waterloo, Canada.

## Excelling in impactful research

In broader terms, PolyU has accomplished several significant milestones in research excellence during the year under review. We achieved high ratings in the University Grants Committee's Research Assessment Exercise (RAE) 2020, in which 70% of our research was rated as "world-leading" or "internationally excellent", affirming the quality and impact of our research work. The encouraging RAE results are an outcome of the hard work and determination of our researchers, and I am grateful for their passion and dedication to advancing the boundaries of knowledge.

## PolyU welcomes delegation of space technology experts


As the only Hong Kong institution involved in the Nation's astronautical projects, PolyU was invited to be one of the co-organisers of a series of events on space technology. As part of the series titled "The Space Programme Scientists enter campus cum Distinguished Chinese Scientists Public Lecture Series", the University was honoured to welcome a delegation of distinguished Chinese astronautical scientists to the PolyU campus in June 2021. The visit included public lectures by these experts. The University's achievements in space technology were also featured in an exhibition held at the Hong Kong Convention and Exhibition Centre.

## PolyU Academy for Interdisciplinary Research established

The University has set up the PolyU Academy for Interdisciplinary Research (PAIR) as a hub to promote research and innovation across different disciplines. Ten research institutes and five research centres are brought together under PAIR to create impactful solutions in areas including artificial intelligence, carbon neutrality, deep space exploration, smart cities and smart energy.

## PolyU launches research centres to support InnoHK

PolyU has joined forces with leading international institutions to develop three research centres to support the HKSAR Government's new InnoHK Clusters initiative. The centres are part of two newly established research clusters, AIR@InnoHK (focusing on artificial intelligence and robotics technologies) and Health@InnoHK (focusing on healthcare related technologies). They bring together leading researchers from around the world to conduct impactful, collaborative research in Hong Kong.

The research centres are:

- Laboratory for Artificial Intelligence in Design (with the Royal College of Art, UK)
- Centre for Advances in Reliability and Safety (with the University of Maryland, College Park, USA)
- Centre for Eye and Vision Research (with the University of Waterloo, Canada)


Laboratory for Artificial Intelligence in Design (AiDlab)


Centre for Advances in Reliability and Safety (CAiRS)


Centre for Eye and Vision Research (CEVR)

# Collaboration with Huawei to nurture digital talent

Since 2007, PolyU has established a long-term partnership with Huawei, and has accumulated rich scientific research results, covering various fields of technologies, including optical communications, big data, crowdsourcing platforms, mobile networks, portable devices, algorithm, and new materials etc.


PolyU and Huawei signed two Memoranda of Understanding (MoUs) on the campus of PolyU and at the Huawei APAC Digital Innovation Congress 2022 respectively to explore in-depth collaboration in photonic technology and strengthen industry-academic exchange and talent cultivation in artificial intelligence.

Huawei and PolyU's newly established Photonics Research Institute jointly advance the technology development of photonics and its applications, by pursuing in-depth research collaborations to address major social challenges, setting up a joint lab and cultivating more young talents and organising joint academic activities.

# Innovative research to advance knowledge and address challenges

PolyU is committed to interdisciplinary collaborative research to address world challenges and improve society. In 2020/21, the University's total research funding amounted to HK$3,662million in support of more than 2,750 ongoing projects, undertaken by almost 880 academic staff and around 2,083 research personnel.

# Major funding boosts research endeavours

In 2020/21, PolyU performed well in the various funding schemes administered by the Research Grants Council (RGC), which operates under the University Grants Committee. The University secured more than HK$315.25million, including funds from the following funding schemes:

| RGC funding schemes<br>研資局資助計劃 | Number of funded project<br>資助項目 | Funding awarded<br>資助金額<br>(HK$ million)<br>(百萬港元) |
|---|---|---|
| Areas of Excellence Scheme<br>卓越學科領域計劃 | 1 | 65.55 |
| Collaborative Research Fund<br>協作研究金 | 5 | 26.46 |
| Research Impact Fund<br>研究影響基金 | 1 | 9.19 |
| National Natural Science Foundation of China/RGC Joint Research Scheme<br>國家自然科學基金委員會／研究資助局聯合科研資助基金 | 10 | 11.57 |
| RGC Senior Research Fellow Scheme<br>研資局高級研究學者計劃 | 1 | 7.80 |
| RGC Research Fellow Scheme<br>研資局研究學者計劃 | 1 | 5.16 |
| RGC Postdoctoral Fellowship Scheme<br>研資局博士後獎學金計劃 | 7 | 8.51 |
| General Research Fund/Early Career Scheme<br>優配研究金／傑出青年學者計劃 | 213 | 157.81 |

The University also secured more than HK$18.71million from the Health and Medical Research Fund of the Food and Health Bureau, to conduct eight research studies on COVID-19. In addition, PolyU received HK$3.152million from the Policy Innovation and Coordination Office of the HKSAR Government for a Strategic Public Policy Research project titled "Study on Effective Transitional Housing Delivery in Hong Kong".

# PolyU Academy for Interdisciplinary Research

In September 2020, the University established the PolyU Academy for Interdisciplinary Research (PAIR), a central research platform to facilitate interdisciplinary research and innovation, technology transfer and collaboration with top institutions in the world. During the year, seven Research Institutes have been set up in areas where PolyU has significant strategic advantages or interests, i.e., advanced manufacturing, artificial intelligence of things, future food, intelligent wearable systems, land and space, photonics and smart ageing, with total funding of HK$210million. A Research Centre for Deep Space Explorations has also been established with funding support of HK$15million. There are currently ten research institutes and five research centres operating under PAIR.


Research Institutes and Research Centres under PAIR

# Awards for innovations and inventions

## 2022 TechConnect Global Innovation Award


- Prof. Jing CAI, Department of Health Technology and Informatics - AI-Empowered Chest X-Ray and CT Quantitative Analysis for COVID-19 Patient Management
- Prof. Hong HU, Institute of Textiles and Clothing - Moisture-Absorbing and Sweat-Releasing Multilayer Polylactic Acid Fabric and Manufacturing Technology
- Dr Dahua SHOU, Professor Jintu FAN and Dr Guanghan HUANG, Institute of Textiles and Clothing - Omni-Cool-Breath: A Smart Air-Conditioned Mask

## 2021 TechConnect Global Innovation Award


- Prof. Jianhua HAO and Ms Sin-Yi PANG, Department of Applied Physics - HF-free facile and rapid synthesis of MXenes related materials for Efficient Energy Conversion and Storage Applications
- Dr Li-Ta HSU and Dr Weisong WEN, Department of Aeronautical and Aviation Engineering - 3D LiDAR Aided GNSS Precise Positioning for Level 4 Autonomous Driving
- Dr Dahua SHOU, Professor Jintu FAN and Dr Xin WEI, Institute of Textiles and Clothing - Sweatextile: A Nature-Inspired Textile of Unidirectional Water Transport and Dissipation for Moisture Management, Comfort and Protection

## 2020 TechConnect Global Innovation Awards

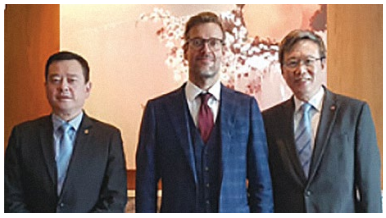
- Professor Pauline Li Pei, Department of Applied Biology and Chemical Technology: Water Dispersible Autofluorescent Polymer Dots Comprising of Non-Conjugated Polymers
- Professor Zheng Yongping and Dr Monzurul Alam, Department of Biomedical Engineering: PolyU Stimulator – Ultrasound Driven Piezoelectric Stimulator for Neuromusculoskeletal Rehabilitation
- Mr Toby Li and Mr Justin Chan, Department of Biomedical Engineering (under the supervision of Dr Wen Chunyi): A Time-dependent Machine Learning-based Prediction System for Progression of Knee Osteoarthritis

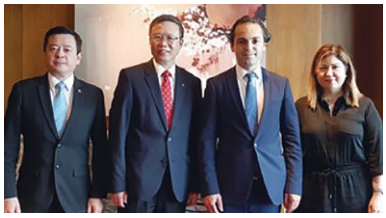
## 13th Guanghua Engineering Science and Technology Award by the Chinese Academy of Engineering

- Professor Tao Xiao-ming, Institute of Textiles and Clothing: Significant contributions to engineering technology and engineering management

## Strengthening links with Consulates in Hong Kong

Professor Jin-Guang Teng, PolyU President, and Professor Ben Young, Vice President (Student and International Affairs), met with the Consul Generals of Australia, Austria, France, Kazakhstan, Pakistan and the UK to explore avenues for cooperation and ways to strengthen the University's global relations and partnership portfolio. In April and May 2021, Professor Teng and Professor Young had fruitful exchange with Mr Peter Robberecht, Consul General of Belgium, and Mr Peyami Kalyoncu, Consul General of Turkey, in Hong Kong. Professor Young also had meetings with the Consul General of Panama and the Government representative of the Virgin Islands to discuss international student recruitment. In addition, the University established links with the Québec Office in Hong Kong for collaboration on talent mobility.





## Tripartite Collaboration Between MTR Corporation, MTR Academy and The Hong Kong Polytechnic University to Focus on Exploring Railway Technology Application and Solutions for Intelligent Maintenance

The MTR Corporation and MTR Academy (MTRA) signed a Memorandum of Understanding ("MoU") today (14 June 2022) with The Hong Kong Polytechnic University ("PolyU") on a three-year collaboration to establish a partnership to focus on exploring advanced and innovative railway technologies and facilitating smart railway asset and operations management, as well as intelligent maintenance.


Leveraging on the railway expertise of the Corporation and MTRA, together with the research competence of smart railway technologies of PolyU, the MoU sets out a framework for the parties to explore innovative solutions and technology applications with the goal to further enhance the performance of railway operations and smart maintenance with smart sensing technology. The collaboration areas include exploring smart solutions for monitoring and condition assessment on railway assets, exploring the establishment of a joint laboratory for rail-technology application, as well as research related to improving the operating environment, for example, passenger flow management in stations.

Witnessed by Dr Rex AUYEUNG, Chairman of MTR Corporation and Dr LAM Tai-fai, Council Chairman of PolyU, the MoU was signed by Dr Jacob KAM, Chief Executive Officer of MTR Corporation, Ms Margaret CHENG, Acting President of MTR Academy, Professor Jin-Guang TENG, President of PolyU and Professor Christopher CHAO, Vice President (Research and Innovation) of PolyU.

# PolyU Recognizes Six Young Innovators with the Young Innovative Researcher Award

Launching for the first time, the new PolyU Young Innovative Researcher Award (YIRA) is a university-level award to recognize young faculty members whose research demonstrate excellence in addressing global challenges. The committee has received many outstanding researches with this year's call, and six talented young researchers have made to their finals. They are Dr. Franco King-Chi Leung from the Department of Applied Biology and Chemical Technology.

The research achievement of the six awardees have covered a wide-range of research areas, from supramolecular robotic system to robot-assisted training for children with autism spectrum disorder. Engineering-focused projects like the human vision-based solutions for lighting and imaging systems and data storage enhancement in ferroelectric materials that will lead future technology advancement. There are also innovative approaches that offer sustainability for a better future like the creation of multinuclear solid atomic catalysts and the research in transportation and humanitarian & social care in Tai O. The selected awardees have demonstrated advancing knowledge in their fields and developed a practical technology or innovation in a unique way to create benefits and bring impact globally.


Top from left: Dr. Tommy Minchen WEI, BEEE; Dr. Sarah Si CHEN, CBS; Dr. Benedict Tsz-woon LO, ABCT & AP.
Bottom from left: Dr. Franco King-chi LEUNG, ABCT; Mr. Daniel Keith Elkin, SD; Dr. Zibin CHEN, ISE.

# Ten PolyU research projects granted Research Impact Fund and Collaborative Research Fund

Ten PolyU research projects have been awarded with a total amount of $47 million from the Research Grants Council (RGC) for three of its funding schemes, namely, Research Impact Fund (RIF) 2021/22, Collaborative Research Fund (CRF) 2021/22 and the second round one-off CRF COVID-19 and Novel Infectious Diseases (NIR) Research Exercise. The RIF supports projects that have potential to translate the research findings and create impact that can benefit society. The CRF supports Research Equipment and Research Projects for acquisition of major research facilities or equipment, and promoting group research across disciplines respectively.


## RGC Research Impact Fund 2021/22

totaling an amount of **$8.8 million**

**"Deeper Understanding of Color Matching Mechanism for Developing High-quality Lighting and Imaging Systems"** by Dr. Minchen WEI, Department of Building and Energy Engineering.

**"Reliable Multiagent Collaborative Global Navigation Satellite System Positioning for Intelligent Transportation Systems"** by Dr. Li-Ta HSU, Department of Aeronautical and Aviation Engineering.

## RGC Collaborative Research Fund 2021/22

totaling an amount of **$24.1 million**

### Research Equipment Grant

**"High Performance Deep Learning Clusters for Big Data Analytics"** by Prof. Xiaojun CHEN, Department of Applied Mathematics

**"An Upright Multiphoton Microscope for Intravital Imaging and Optogenetic Studies"** by Prof. Mo YANG, Department of Biomedical Engineering

**"Advanced Fourier-transform Electron Paramagnetic Resonance Spectrometer for Molecular and Nano Functional Materials Research"** by Prof. Raymond Wai-yeung WONG, Department of Applied Biology and Chemical Technology

### Research Project Grant

**"Development of High-Resolution 3D Scaffolds with Biomimetic Triply Periodic Minimal Surface Structure for Bone Tissue Repair"** by Dr. Xin ZHAO, Department of Biomedical Engineering

**"Study of Carbon Sequestration in Hong Kong's Vegetation: from Present to Future Prediction under Climate Change"** by Prof. Man Sing Charles WONG, Department of Land Surveying and Geo-Informatics

## Second round one-off CRF COVID-19 and Novel Infectious Diseases (NIR) Research Exercise

totaling an amount of **$14.1 million**

**"Is the Usual Social Distance Sufficient to Avoid Airborne Infection of Expiratory Droplets in Indoor Environments?"** by Ir Prof. Hai GUO, Department of Civil and Environmental Engineering

**"The Effect of Distance Design Collaboration Necessitated by COVID-19 on Brain Synchronicity in Teams Compared to Co-Located Design Collaboration"** by Dr. Yi Teng SHIH, School of Design

**"Spatiotemporal Prediction and Real-time Early Warning of COVID-19 Onset Risk"** by Prof. Wenzhong John SHI, Department of Land Surveying and Geo-informatics

# PolyU insights shared at GBA Engineers Forum

The 2021 Greater Bay Area Engineers Forum was successfully held simultaneously in Hong Kong and the Guangdong-Macau In-depth Cooperation Zone in Hengqin in December 2021.

The theme of the Forum was "bringing engineering elites together to foster Greater Bay Area development". The hybrid event was composed of three forums and one seminar. The event was well received, with more than 500 engineering experts attending.

Professor Jin-Guang Teng, President of PolyU, delivered a keynote speech on the role of Hong Kong's engineering technology in the development of the Greater Bay Area. He shared his insights on how university research helps promote technological innovations for industrial applications.

The event was jointly organized by professional bodies including China Association for Science and Technology, the Hong Kong Institution of Engineers, and the Beijing-Hong Kong Academic Exchange Centre, with PolyU as the supporting organizer.

# PolyU students win awards in the 7th Hong Kong University Student Innovation & Entrepreneurship Competition

PolyU students were awarded in the 7th Hong Kong University Student Innovation & Entrepreneurship Competition for their outstanding performance in advancing technology development in different aspects. Among all the First Prizes, the PolyU team from Zhang Heng Kai, Ren Zhiwei, Liu Kuan was granted the Grand Prize (Innovation) for their project "High Performance Solution-Processed Perovskite Solar Cell Towards Sustainable Development", which was appraised with high potential for further development. Prof. Christopher Chao, Vice President (Research and Innovation) joined the award presentation ceremony on 27 Nov 2021 and shared the joy of the awarded teams.

## List of PolyU Awardees:

### Energy, Environmental & Chemical Engineering

#### First Prize:

**High Performance Solution-Processed Perovskite Solar Cell Towards Sustainable Development** by Zhang Heng Kai, Ren Zhiwei, Liu Kuan

#### Merit Prize:

**Construction Noise Permit Application System Based on Geographic Information System and Noise Control Ordinance** by Chiu Kai Yim, Wong Ho Lun, Lee Wing Sze, Lee Chantel Alexandra, Suen LokFai, Ivan Jasper Istanto, Kong Yiu Lun

**Performance Analysis of Bifacial Solar PV Module and its Application in Hong Kong** by Hung Tak Lam, Lam Nico, Leung Chun Kuen

### Information Technology

#### Second Prize:

**Intelligent Driver Health Assessment System Based on the Optical Fiber Interferometer** by Yu Jianxun, Chen Shuyang, Qu Jiaqi

#### Merit Prize:

**Milky Assistant** by Leung Yee Ting

### Mathematics and Physics / Mechanics and Control Systems

#### Merit Prize:

**Adopting VR and AR Technology to Minimize Human Casualty in Construction Site** by Ho Ho Nam, Wong Kwong Sau

## Entrepreneurship Proposal

### Second Prize:

**Electricity-free Smart Cooling Coating** by Yang Ning, Fu Yang

## Startup

### Thrid Prize:

**Probiotics protected by Aerospace Material** by Gu Yinlin, Yu Xuanjie, Chang Jinhui, Dr. Jin Yong

**FJ005** by Lee Jwo Lem Max , Ng Hoi Fung, Wen Weisong, Chan Wing Hei Josua,Hsu Li Ta

## Social Enterprise /Cultural & Creative Services

### Thrid Prize:

**Best Value** by Ng Hoi Kam, Lam Pui Yi Yip Pui Sze, Ng Yim Hung, Pang Chee Tsun Marcus,Yue Karen Ashley

Organized by Hong Kong New Generation Cultural Association, the competition is aimed at selecting the most outstanding projects to represent Hong Kong in the aforementioned national stages, exposing talented Hong Kong students to cutting-edge innovative and entrepreneurship ideas and inspiring them with academic exchange among the brightest students nationwide. Through this eye-opening, first-hand experience, it is hoped that students could further develop their potential, sharpen their presentation and interpersonal skills and become future innovation and entrepreneurship leaders.

## PolyU-Shenzhen Technology and Innovation Research Institute (Futian) established

The PolyU-Shenzhen Technology and Innovation Research Institute (Futian) was established to harness the opportunities offered by the development of the Greater Bay Area (GBA) to add impetus to the impactful research produced by PolyU. Supported by the Shenzhen-Hong Kong Science and Technology Innovation Cooperation Zone (Pilot Scheme), research conducted by the Institute commenced with the project "Theories of Geo-Artificial Intelligence and Reliable Spatial Data Analytics", which is led by Professor John Shi, Chair Professor of the Department of Land Surveying and Geo-Informatics. Initiated with a start-up grant and a rent-free office from the Futian Government, the project will contribute to smart city development in GBA cities, as well as other cities in Mainland China and around the world.

## PolyU and ASTRI join hands to foster research collaboration and nurture R&D talent

The Hong Kong Polytechnic University (PolyU) and The Hong Kong Applied Science and Technology Research Institute (ASTRI) have signed a Memorandum of Understanding (MoU) to strengthen collaboration on research and technology transfer as well as to nurture future R&D talent, leveraging the research expertise of both parties.

PolyU and ASTRI capitalizes on their respective research experience and strengths to develop impactful innovations. The two parties are committed to encouraging more interdisciplinary research discussions and strengthening cross-sector technology transfer.

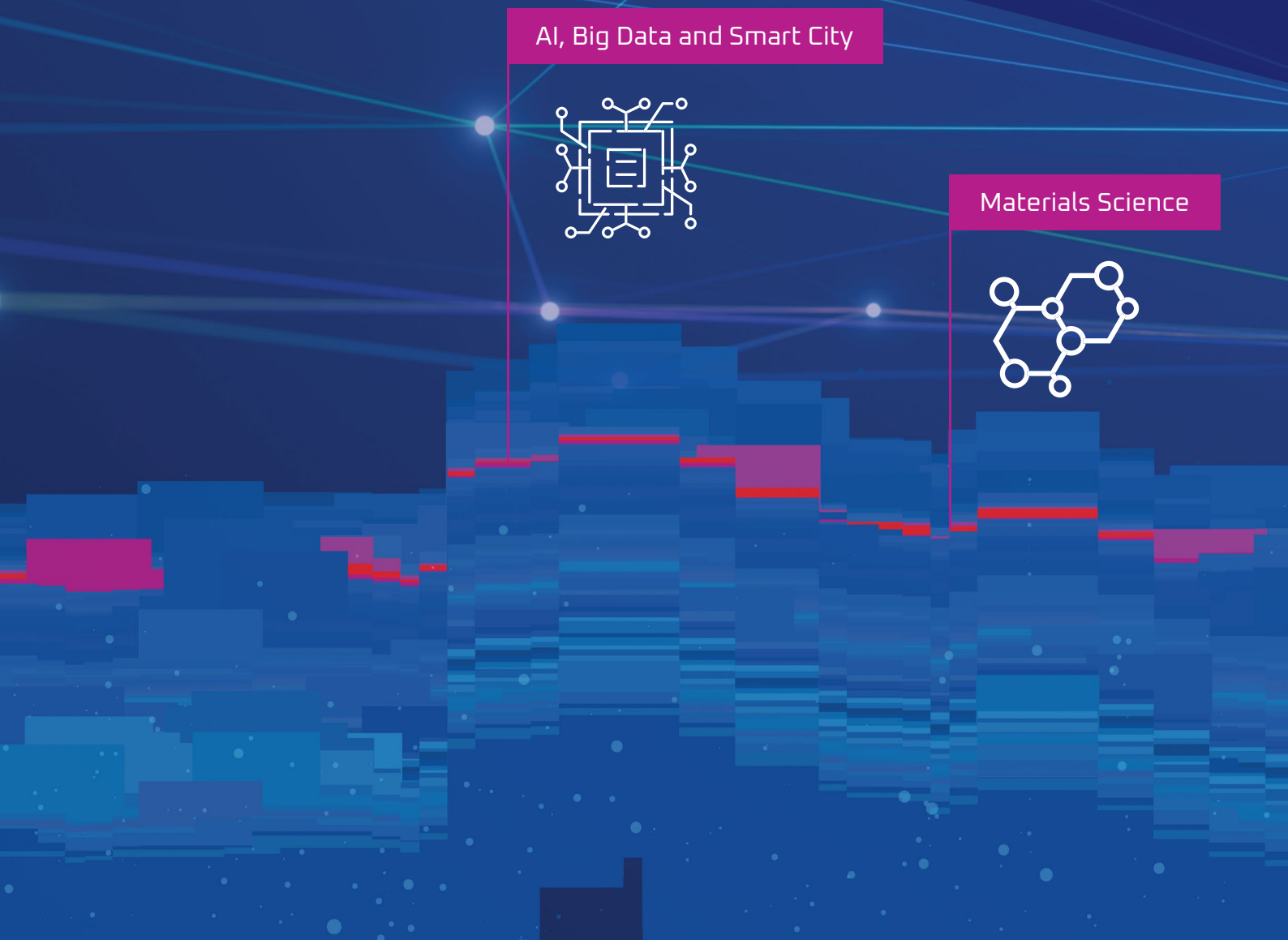
With cultivating young talent as a core mission of the collaboration, PolyU and ASTRI are dedicated to building a strong talent base for the long-term and sustainable development of R&D in Hong Kong.

# Joining hands with CAIR-HKISI-CAS to advance AI, DS and Robotics technologies

Under the support of the Department of Computing and Research Centre on Data Science and Artificial Intelligence (RC-DSAI), PolyU signed a collaborative agreement with the Centre for Artificial Intelligence and Robotics, Hong Kong Institute of Science & Innovation, Chinese Academy of Sciences (CAIR-HKISI-CAS) to advance Artificial Intelligence (AI), Data Science (DS) and Robotic technologies research. With a longstanding collaboration with CAS, PolyU expands and deepens its existing partnership and enters into cooperation with CAIR-HKISI-CAS.

This agreement offers a framework for collaboration to develop and apply innovative technologies in the fields of AI, DS and Robotics, to generate high impact research as well as to nurture talents and benefit mankind. The collaboration marks a new milestone in PolyU's development and represents our earnest efforts in fostering long-term academic and research collaborations. Through leveraging the university's competitive edge in education, research and complementing the strengths of CAIR-HKISI-CAS, the two parties will contribute to pursuing impactful research that benefits the region, the country and the world.

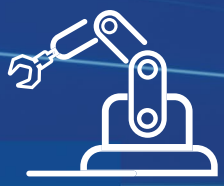
# Science & Engineering Showcase



Biomedical and Chemical Engineering

Carbon Neutrality and Sustainable Developments

Advanced Manufacturing



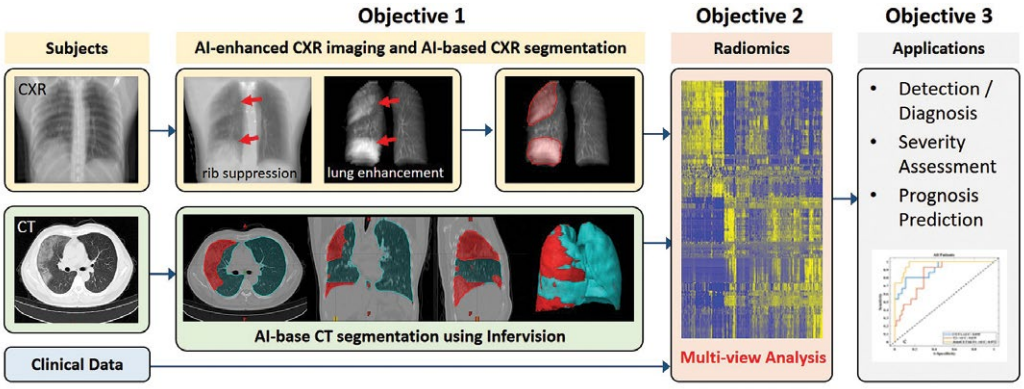
# AI, Big Data & Smart City

## AI-Empowered Chest X-Ray (CXR) and CT Quantitative Analysis for COVID-19 Patient Management (TechConnect Award Innovation)

he presence of mild or no image findings in early cases of COVID-19 highlights the difficulties of early detection and diagnosis using current CXR and CT imaging and image analysis methods. This analysis combines the deep learning methods with radiomics and yielded multiple novel AI-empowered techniques tailored for COVID-19 clinical applications, including AI-enhanced CXR, AI-assisted segmentation, multi-view analysis, and multi-omics framework. Our innovative multi-view analysis method can effectively handle different data types and best utilize the multi-dimensional information from these data.

It provides an accurate and low-cost imaging method for diagnosing and monitoring COVID-19 by analysing information from medical imaging, clinical data and laboratory measurements. The developed technology is a potential tool in the fight against COVID-19 and similar pandemics in the future. It will produce multiple useful predictive models for COVID-19 detection, diagnosis, severity stratification, and prognosis.

The AI-enhanced CXR technique developed in this technology can provide an accurate and low-cost imaging method for the diagnosis and monitoring of COVID-19. Its high accessibility will benefit many peripheral hospitals in China and other developing countries that do not have the needed resources to accurately diagnose and monitor COVID-19.



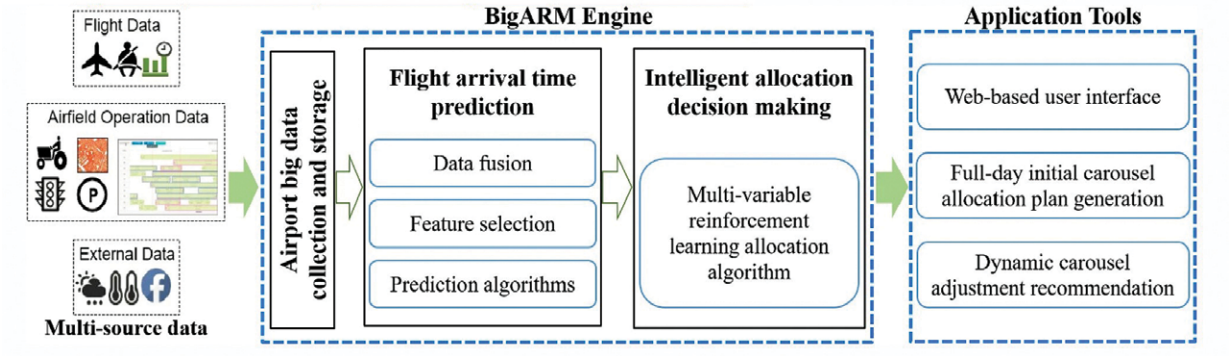

Overall design and workflow of the system

## Pedestrian Traffic Monitoring Platform (Smart50 Awards)

This platform enables traffic flow monitoring that rolls out data collection with high accessibility for stakeholders. Initiated from a collaborative project to collect pedestrian traffic flow data in Tai O Village, an ecological and cultural tourism centre under the Sustainable Lantau Blueprint of Hong Kong, having recently anticipated increase in tourism and surges in tourist traffic, PolyU partnered with the Tai O Village Rural Committee and various community groups to monitor pedestrian traffic into the Village. It monitors pedestrian traffic into the Village using infrared passage gates installed in eight major infrastructure connections. This platform is distinct that it follows a collaborative model using inexpensive technology for consumer products to get data quickly with high accessibility.

## 'BigARM' - Big Data Engine for Smart Airport Resource Optimization and Management

In support of the Hong Kong International Airport, PolyU developed a 'BigARM' engine equipped with powerful big data analytics and AI techniques to achieve efficient and intelligent airport resource management. It consists of an airport big data collection and storage module, a data-driven dynamics prediction module, as well as an intelligent resource allocation module for supporting various applications. Notably, BigARM has achieved significant improvement in the accuracy of flight arrival time prediction and arrival bag count prediction. Moreover, it has also helped to reduce the time of full-day allocation planning from several hours to a few seconds, which dramatically reduces the operator workload and increases the efficiency of airport resource management.



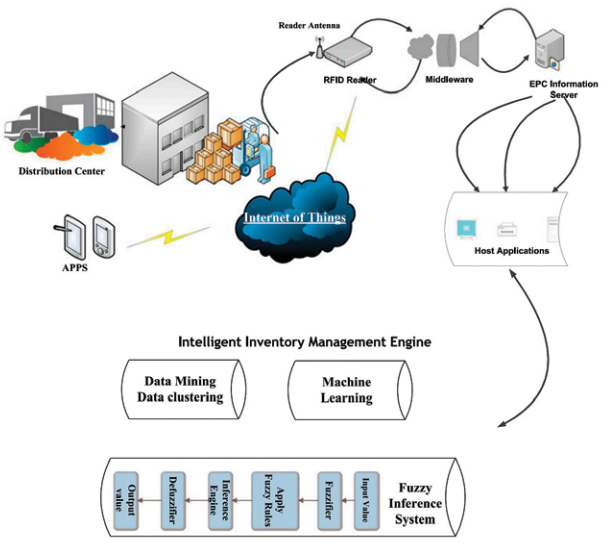

Design of BigARM system

## Artificial Intelligence Industrial Internet of Things Based Robotic Warehouse Management System

PolyU developed a cyber-physical solution for smart logistics: streamlining the efficiency, transparency and cost consideration on inbound logistics are critical factors for seamless delivery experience; it is always a challenge for supply chain to match real-time order with its order fulfilment. Our cyber-physical solution is fully visible over the inbound logistics by analysing the real-time demand and improves racks allocation via collaborative swarm robots.

Without sacrificing the capacity of order fulfilment, the demand-driven re-slotting and order fulfilment are performed simultaneously by the swarm mobile robots. Regarding the discrepancy between order fulfilment demand and predicting of rack re-slotting requirements, mobile robots with swarm intelligence is assigned with different roles of task. With aids of the cyber-physical warehouse systems, order fulfilment status in actual operations and demand for e-commerce products are synchronized and connected with "Digital Twin" to cope with the e-commerce-level dynamics.

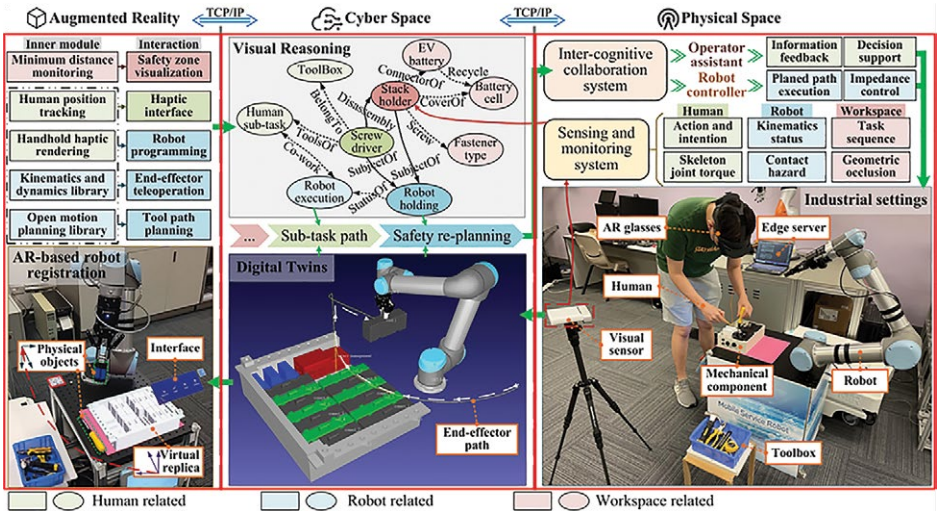
The potential applications include express smart e-commerce electronic computerized parcel locker and robotic warehouse with smart locker function.




The framework of proposed IoT-based warehouse management system

## A Multimodal Intelligence-Based Mixed Reality System for Mutual Cognitive Human-Robot Collaboration

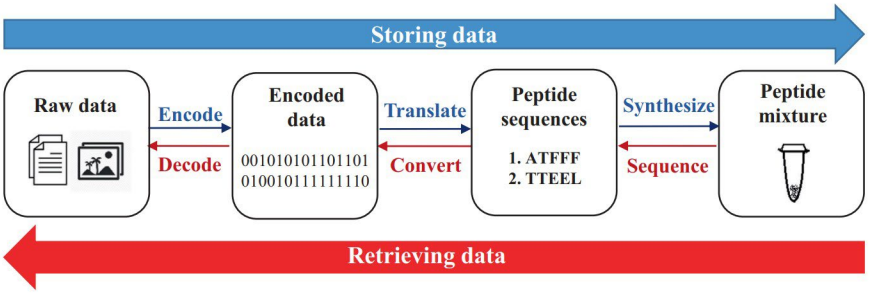
This innovative technology provides an AI-enabled adaptive and intuitive HRC system with mutual cognitions for flexible automation capabilities in smart manufacturing. Vision-based HRC holistic scene perception has first been achieved, then implemented a mutual cognitive HRC safety system based on digital twin and augmented reality (AR). Through a visual reasoning-based approach cognitive decisions are deployed in the AR execution loop for intuitive HRC support. The vision-based HRC holistic scene perception has an average accuracy >97%; the deep reinforcement learning-driven motion planning for proactive collision avoidance is <0.5%; the overall response time for AR deployment of visual reasoning-based cognitive decisions is <0.4s. It is envisioned that the technology can be adopted in other scenarios with human-in-the-loop across many fields, such as industrial inspection, material preparation, surgical operations, etc.




System structure of the prototype mutual cognitive HRC system

## Data Storage Using Peptide Sequences

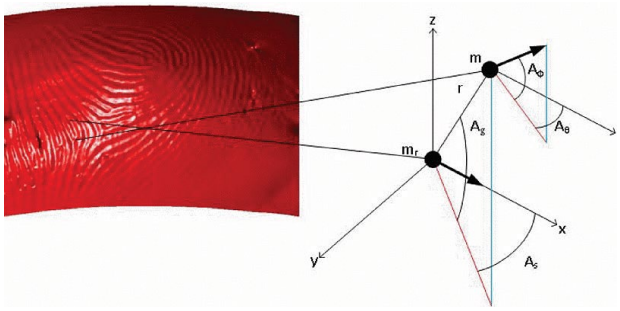
This innovation draws inspiration from proteomics and gives new insight in data storage in large: in response to the huge amount of digital information generated today, this novel method is developed by using peptide sequences to store data and retrieving it via tandem mass spectrometry. Compared with existing commercial data storage devices and other developing technologies, such as DNA data storage, peptides offer a much higher storage density and longer storage duration. Combining proteomics and data storage technology, this innovation has the potential to transform the data storage industry, including to be deployed in space mission!




Overview of the process of storing and retrieving data into and from peptides. The direction in blue represents the data storing process, while the direction in red represents the data retrieving process.

## 3D Low-Cost, Contactless and Accurate Fingerprint Identification System

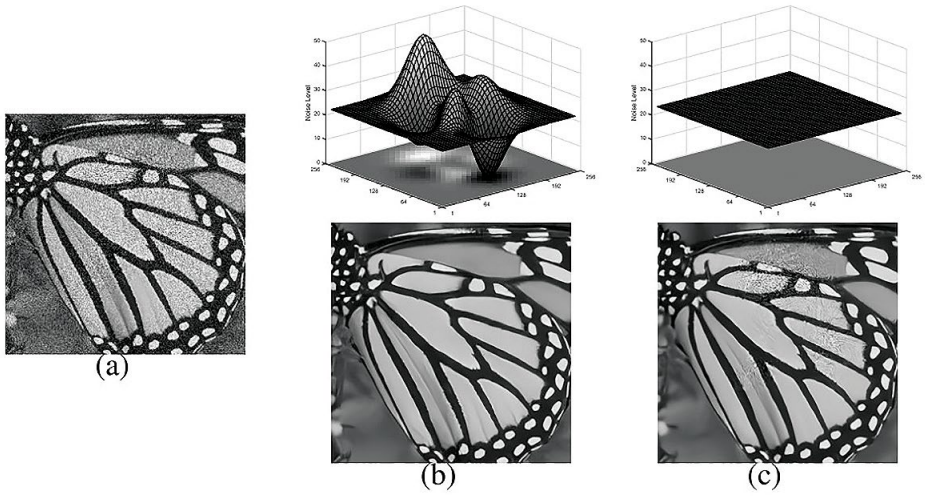
This is a low-cost and more accurate contactless 3D fingerprint identification system developed to provide more accurate personal identification as rich information is available from 3D biometrics images. The minutiae details in two-dimensional space are widely used by the law-enforcement personnel and employed in almost all the fingerprint system commercially deployed today. The 3D system has been able to accurately recover and match these fingerprint minutiae details in three dimensional spaces. This research is also fundamentally significant as it reveals that such recovery and matching of 3D minutiae features will significantly alter the theoretical belief of the limit of the accuracy of identifying the human's population using fingerprints.




Computing relative localization of two 3D minutiae features in 3D space from the (real) reconstructed 3D fingerprint.

## High Performance Video Quality Denoising by Deep Learning

A novel algorithm to better visual quality and provides video denoising: a deep-learning-based video denoising method without motion estimation is developed. First, the patches at the same spatial location across adjacent frames as a patch group are staked and learn a patch group prior model from a set of clean training videos. The patch group prior exploits the local temporal redundancy of video to remove noise. Then, a flexible denoising convolutional neural network is learned to exploit video spatial redundancy, as well as global temporal redundancy of video. The proposed algorithm exhibits better visual quality as well as quantitative measure than other state-of-the-art video denoising methods and can be largely accelerated with GPU, provides a powerful tool for practical video denoising.



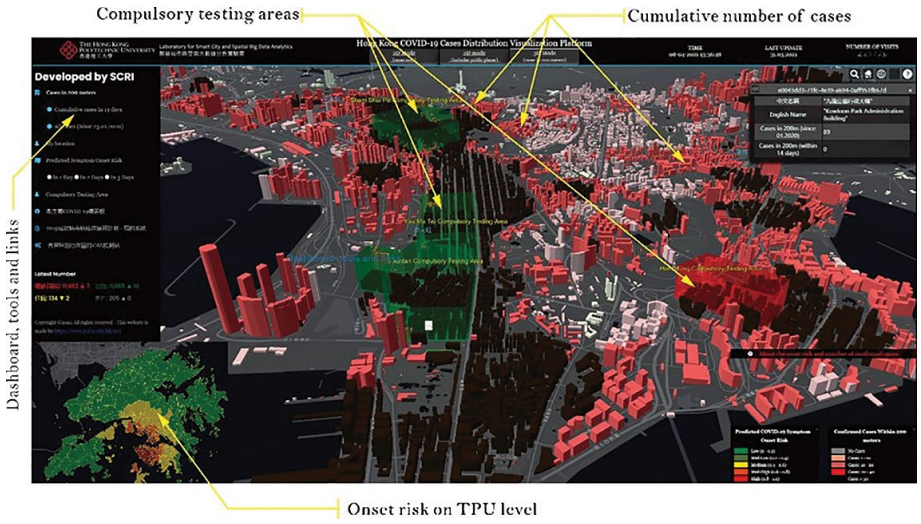

Examples of FFDNet on removing spatially variant additive white Gaussian noise (AWGN).
(a) Noisy image (20.55dB) with spatially variant AWGN.
(b) Ground-truth noise level map and corresponding denoised image (30.08dB) by fast and flexible denoising convolutional neutral network (FFDNet);
(c) Uniform noise level map constructed by using the mean value of ground-truth noise level map and corresponding denoised image (27.45dB) by FFDNet.

## Self-sustainable Electrical Sensors and Condition Monitors for Smart Cities

The electricity transport and utilization activities can now be loyally, safely, smartly, and continuously guarded by PolyU's "Self-sustainable Electrical Sensors (SsESs)" and the "Energy-harvesting Self-powered Wireless Condition Monitors (EhSpWCMs)" without the needs of external power supplies, signal conditioners, or other active auxiliaries to sustain their operations. SsESs can be simply placed on any sensing point of interest (e.g. cables, conductors, busbars, etc.) to detect electrical currents and temperatures while harvesting and also powering microcontroller, memory, display, wireless transmitter, etc. associated with EhSpWCMs. The technology can be applied to sensor and condition-monitoring markets for all electrical devices, equipment, systems, assets, and infrastructures, ranging from personal and home appliances to residential, commercial, and industrial facilities as well as from public utilities to national infrastructures, military defence, and space systems.

## A Comprehensive Spatial Analysis and Onset Risk Prediction Platform for COVID-19 Pandemic in Hong Kong (Smart 50 Award)

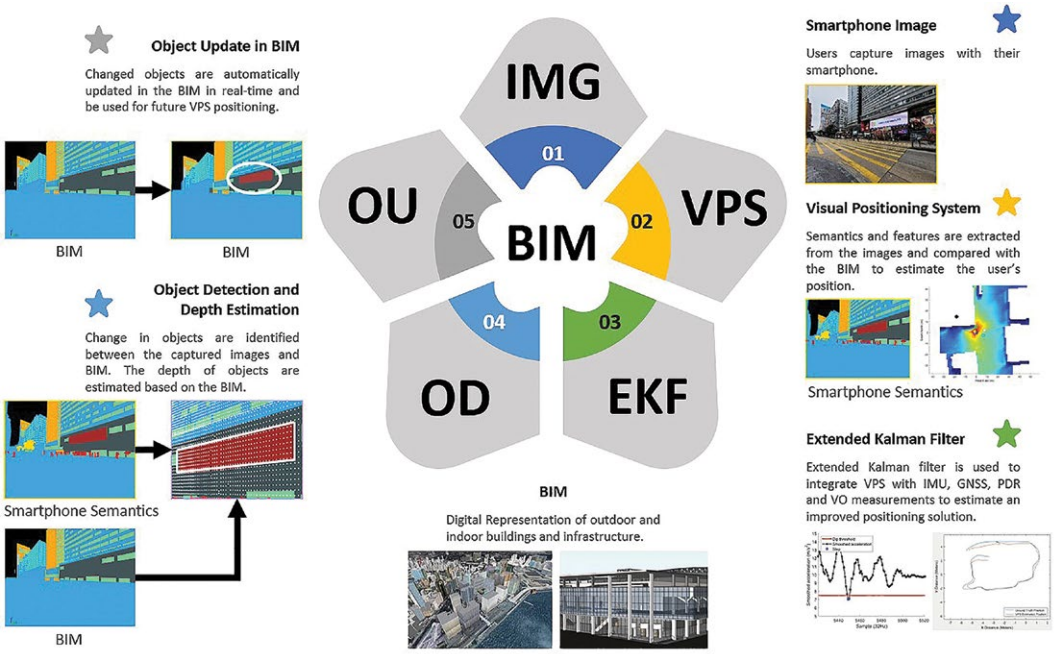
In response to the COVID-19 pandemic and the risks imposed on everyday activities in Hong Kong, PolyU has established a city-level epidemic data dashboard and risk prediction system for the public to track the community spread of the epidemic. The COVID-19 risk prediction algorithm is developed by analysing Hong Kong's urban structure, transportation network, population environment and other socio-economic data using spatial big data technologies and analyses. This provides an accurate prediction of the development trend of the epidemic in a timelier manner and support the public health department to formulate more precise prevention and control strategies.




COVID-19 3D dashboard and onset risk prediction platform

## Visual Positioning System Based on Building Information Modelling

Most of these old buildings do not have 3D indoor Building Information Models (BIM), which creates many challenges when it comes to reconstruction or maintenance. In view of this, PolyU has developed a lightweight and reliable 3D mobile mapping system, which can easily measure cities and obtain 3D maps with centimetre-level accuracy. It can be used to build spatial data infrastructure and can thus support smart city applications in many fields. The system adopts advanced technologies such as Simultaneous Localisation and Mapping (SLAM), which is not restricted by the signal receiving area of the Global Navigation Satellite System (GNSS). It can carry out continuous data collection in different complex indoor and outdoor environments and is particularly suitable for high-density and complex urban environments, such as those in Hong Kong.




Vision Positioning System Diagram

## 3D Lidar Aided GNSS Precise Positioning for L4 Autonomous Driving (TechConnect Innovation Award)

This 3D LiDAR-Aided GNSS Precise Positioning technology tightly couple the environmental perception capability with high-precision satellite positioning technology that is equipped with an intelligent self-adjusting satellite ranging measurement modelling and correction. This allows highly robust centimetre-level high-precision global positioning in urban environments to be achieved for L4 autonomous driving, mobile robots, and drones.

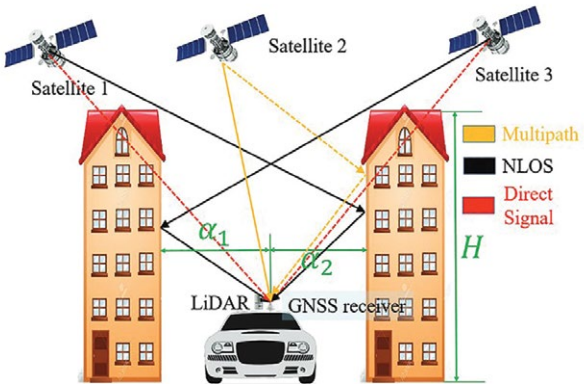


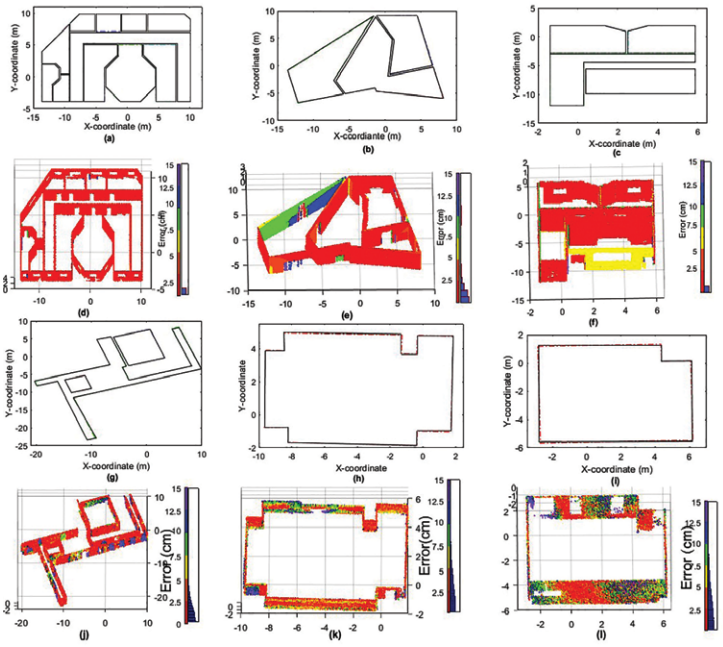

Illustration of GNSS signal transmission routes in the urbanized area in Hong Kong

## Evidence-Based Community Engagement for Kai Tak Supported by Spatial Analysis Technologies

Hong Kong is an international metropolitan city with a severe shortage of land supply for housing development. Although minor relaxation of plot ratio and/or building height restrictions presents a possible path to provide housing opportunities, its impact on the surroundings must be carefully analysed. For the Kai Tak development area, PolyU has provided vivid 3D what-if analyses of different scenarios on the surrounding environment for effective community engagement. This is achieved using 3D modelling, 3D spatial analysis, and CFD simulation to analyse the impact of minor relaxations on urban skylines, mountain ridgelines, shadow and lighting, air temperature, and wind ventilation. This evidence-based approach has been used to engage various stakeholders and significantly improved the efficiency and effectiveness of community engagement.

## Lightweight 3D Seamless Spatial Data Acquisition System (SSDAS)

With the continuous urbanization of Hong Kong, the complexity and heterogeneity of spatial data in 3D and temporal-dimensions raise new challenges to the traditional 2D geodatabases. There are 2 features in this design: 1) 3D geodatabase framework design, and 2) Lightweight 3D Seamless Spatial Acquisition System. For the framework design, it has the capability to provide comprehensive topological relationship modelling, detailed 3D geospatial modelling, semantic and geometric modelling and interactive geo-visualization in 3D. While the SSDAS can integrate multi-sensor with an all-in-one mobile platform and light in weight. This application will be applicable for geospatial modelling on complex city environment like Hong Kong.



(a-f) Evaluation of reconstructed models from synthetic datasets:
(a-c) Comparison of the 2D floor plans (black lines) and reconstructed models (coloured lines), and
(d–f) distance of points to the nearest reconstructed plane (a histogram of errors is shown at right side).
(g-l) Evaluation of reconstructed models from BLS:
(g-i) Comparison of the 2D floor plans (black lines) and reconstructed models (coloured lines), and
(j-l) distance of points to the nearest reconstructed plane (a histogram of errors is shown at right side).

## Smart Monitoring System for Urban Tree Management (Smart 50 Awards)

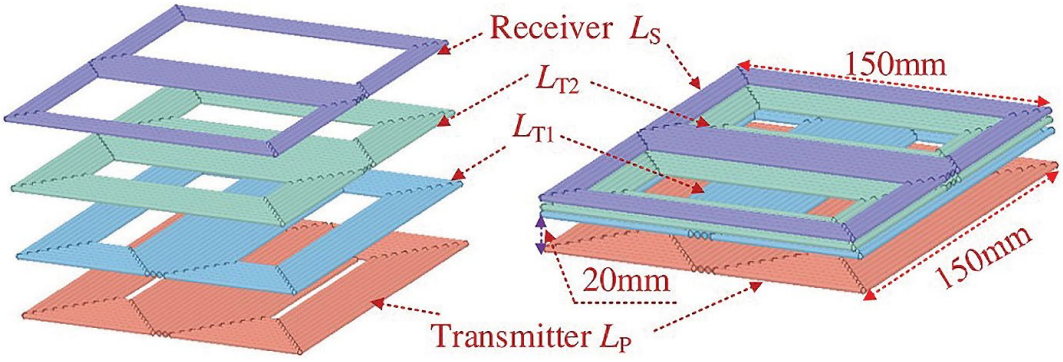
Tree risk assessments in areas with high pedestrian and traffic flow needs to be conducted and implement appropriate risk mitigation measures to safeguard the public from falling trees, especially during increasing extreme weather events. To address this issue, PolyU collaborated with the Hong Kong Development Bureau with the support of The Hong Kong Jockey Club Charities Trust to develop a smart tree monitoring system to track tree stability on a territorial-wide scale. Their team assessed the risk of tree failure by monitoring trees' swaying or tilting condition by applying spatial big data analytics with AI on the GIS-based platform. The whole pilot scheme involves the installation of about 8,000 sensors on selected urban trees across Hong Kong territorial wide. Going forward, with the successful implementation of the pilot scheme, the smart tree management system will be migrated to the government to better benefit the city's urban green management as a whole.

The sensor installed on lower tree trunk for monitoring tilt angles

## Intermediate Resonant Circuit Based Wireless Charging Technology

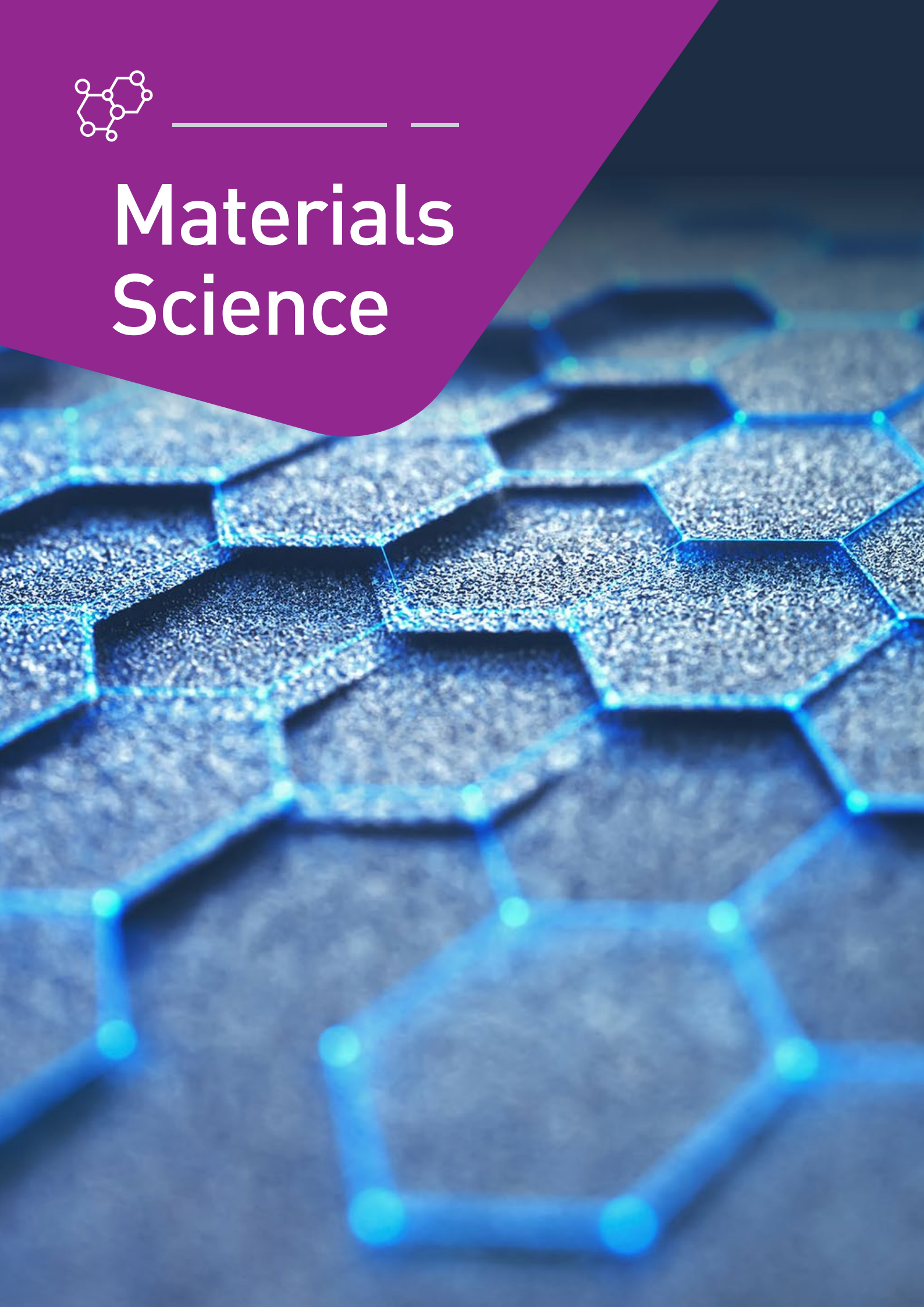
Existing wireless charging technologies for electric vehicles require complex sensors, closed-loop controllers and communications facilities which resulted in bulky size. Our new wireless charging technology based on a novel reconfigurable intermediate resonant circuit is designed to reduce the complexity and increase efficiency and reliability. Based on a new magnetic coupling structure, the system is able to achieve wireless load-independent constant current charging and constant voltage charging without the need of communication between the receiver and the transmitter side.

This new technology stimulates the large-scale deployment of electric vehicles with wireless charging, and can be applied for mobile items like electric bicycles and smart phones.



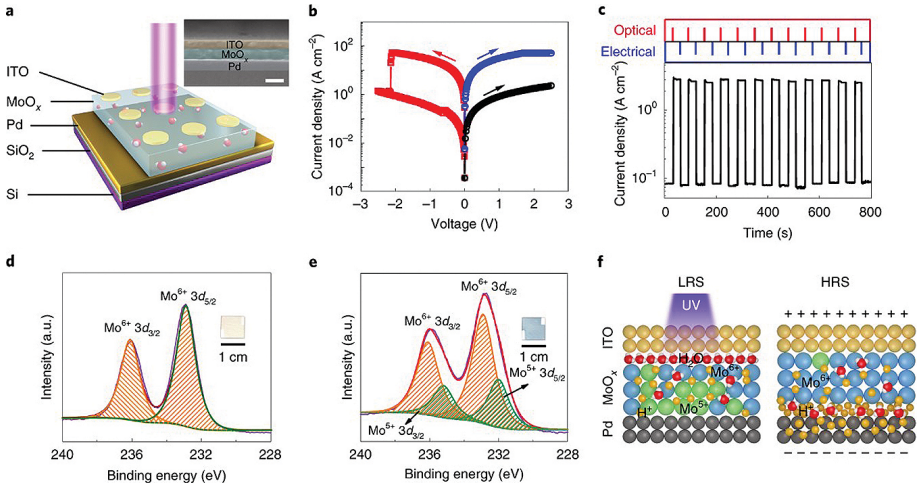

Three-dimensional view of the proposed coil structure

# Materials Science



## Optoelectronic resistive random-access memory for neuromorphic vision sensors

Neuromorphic visual systems have considerable potential to emulate basic functions of the human visual system even beyond the visible light region. However, the complex circuitry of artificial visual systems based on conventional image sensors, memory and processing units presents serious challenges in terms of device integration and power consumption. PolyU has invented simple two-terminal optoelectronic resistive random-access memory (ORRAM) synaptic devices for an efficient neuromorphic visual system that exhibit non-volatile optical resistive switching and light-tunable synaptic behaviours. The ORRAM arrays enable image sensing and memory functions as well as neuromorphic visual pre-processing with an improved processing efficiency and image recognition rate in the subsequent processing tasks. This novel device provides the potential to simplify the circuitry of a neuromorphic visual system and contribute to the development of applications in edge computing and the internet of things.




a, Schematic structure of the MoOx optoelectronic resistive random-access memory (ORRAM).

b, Optical set and electrical reset in a d. c. sweeping mode. The black and blue lines show the voltage sweeping before and after the removal of UV illumination. The red line shows the voltage sweeping for the electrical reset process.

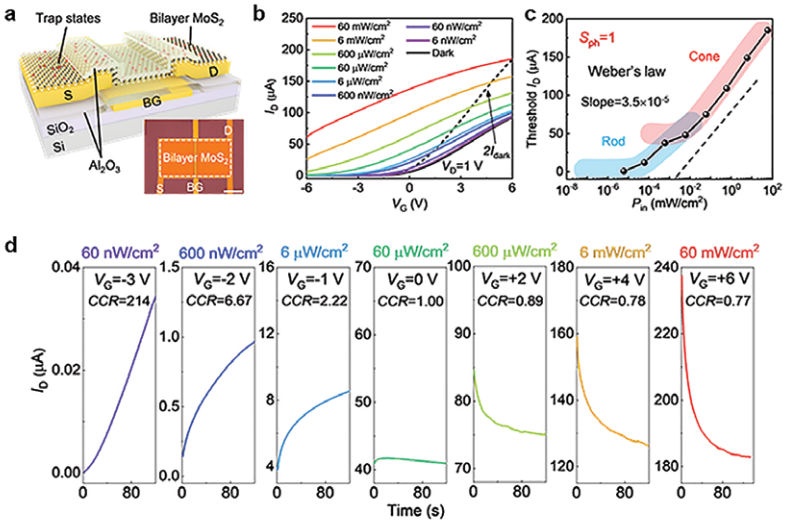
c, Pulse-switching characteristics.

d, e, Narrow scans of the Mo 3d peak for the MoOx layer before (d) and after (e) UV illumination. Insets, the photos of the MoOx thin film prepared on a quartz substrate before (d) and after (e) UV illumination clearly show the colour transition associated with resistance change.

f, Proposed switching mechanism in the MoOx ORRAM. The resistance state transition is associated with the valence state change of Mo.

## Bioinspired in-sensor visual adaptation for accurate perception

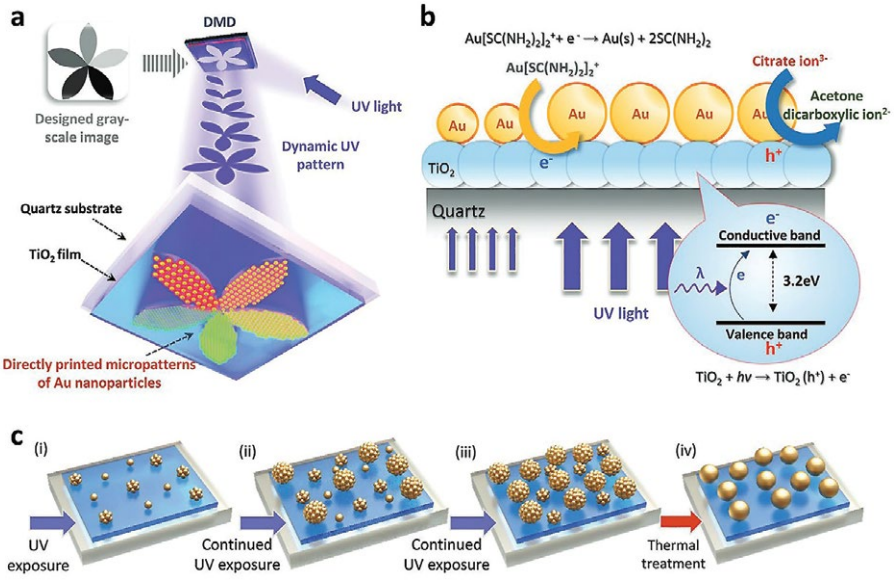
Machine vision systems capturing images for visual inspection and identification should be able to perceive a scene under a range of illumination conditions. The existing systems use circuitry and algorithms that compromise efficiency and simplicity. To circumvent such compromise, PolyU invented bioinspired vision sensors based on $MoS_2$ phototransistors. In this invention, charge trap states are intentionally introduced into the surface of the $MoS_2$, enabling dynamic modulation of the photo-sensitivity under different lighting conditions. The perceived change in stimuli of the device sensor is proportional to the light stimuli. The approach offers visual adaptation with highly localized and dynamic modulation of photo-sensitivity under different lighting conditions at a pixel level, creating an effective perception range of up to 199 dB. The phototransistor arrays exhibit image contrast enhancement for both scotopic and photopic adaptation. This bioinspired in-sensor visual adaptation could be applied in machine vision, simplifying or reducing circuitry and complex processing algorithm requirements.




(a) Schematic structure of the $MoS_2$ phototransistor. Inset: Optical microscope image of an individual $MoS_2$ phototransistor.
(b) Transfer characteristic curves of the device measured at $V_D$=1 V under different $P_{in}$ (660 nm wavelength).
(c) Threshold $I_D$ as a function of $P_{in}$ at $S_{ph}$=1 extracted from (b).
(d) Time-dependent current ($I_D$) of the device under different $V_G$ according to different $P_{in}$.

## Precision Photo-Reduction Technology for Fast and Direct Printing of Micro-Patterned Plasmonic Structures

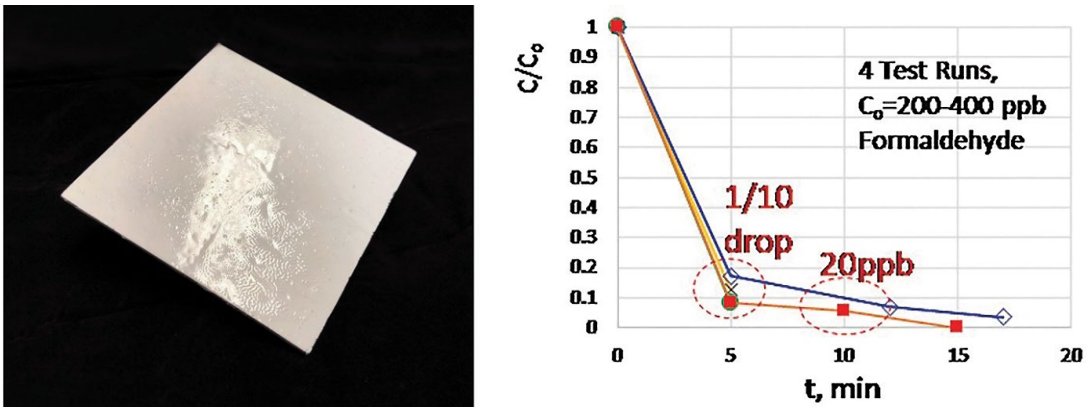
This novel precision photo-reduction technology for plasmonic substrates and micro-device development is developed for fast, direct and cost-effective printing of micrometre-scale patterns with size-controlled silver/gold nanoparticles. This technology stems from a combination of digital ultraviolet (UV) lithography technology and light-controlled photo-reduction method and can rapidly and precisely control the growth of metal nanoparticles on a photocatalytic layer.




Schematic diagrams for direct micropattern printing of size-controlled AuNPs.
a) Mask-less ultraviolet exposure technology for precision photo-reduction;
b) light-controlled growth of AuNPs on the photocatalyst layer;
c) process flow for light-controlled growth and thermal reshaping of AuNPs.

## Whitewash

Whitewash is a photocatalyst made of Titania composite that absorbs visible light, even under diffuse light condition, and generates necessary radicals that oxidize harmful gas molecules, viruses and bacteria. This photocatalyst are made into nanofibers with diameter less than 1/1000 times that of human hair. When combined with oxygen and water vapor in air, special ions and radicals are produced to oxidize the undesired gases adsorbed on the photocatalyst. As such, this innovation can be applied in air purification and disinfection services in various public facilities and healthcare settings, such as elevators, vehicle cabins, hospital wards, commercial kitchens to safeguard public health.




Whitewash coated on glass tile (Left), Whitewash is capable of purifying 300 – 400 ppb of formaldehyde (Right)

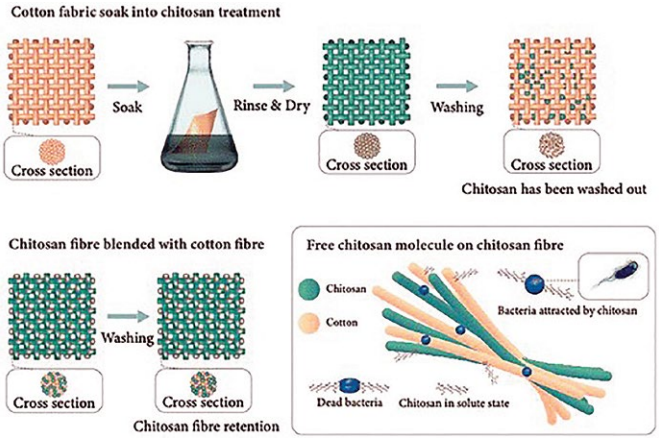
## Energy Conversion Through Durable Single Chamber Solid Oxide Fuel Cell

High performance and durable single chamber solid oxide fuel cells (SC-SOFCs) are developed for efficient energy conversion at 500-700°C. The cathode is the key to realize the efficient and durable operation of SC-SOFC, as typical cathode materials degrade significantly in a CO -rich environment. Cobalt-free novel perovskite oxide materials SrScTaFeO (SSTF75) are fabricated as SC-SOFC cathode. The materials showed excellent activity (very low resistance) towards oxygen reduction reaction (ORR) and high resistance to CO. SC-SOFC demonstrated excellent stability in CO environment and delivered high power density of over 1.4W/cm$^2$ at 650°C, exceeding the performance of existing SC-SOFCs.

The SC-SOFCs can be used for ombined heat and power co-generation, a backup power source for vehicles and various stationary applications. It can make significant contribution to sustainable energy conversion.

## Chitosan Medical and Health Textile Solution

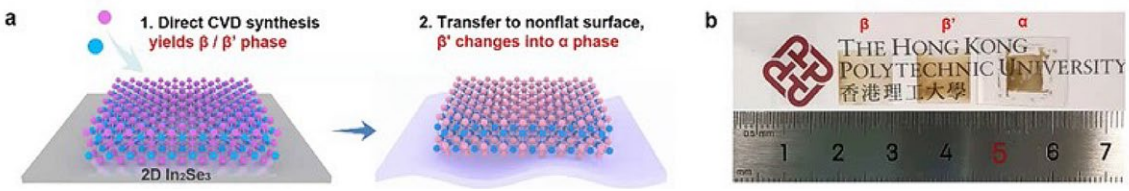
Chitosan material has multiple functions that attracts attention from the textile industry, while textile structures make the biocompatible, osteo-conductive and resorbable material promising in a wide range of applications. When the material becomes fibres, the resulting length, strength, fineness and softness would grant the material functions such as structure capacity and a layering system. However, the expected win-win situation is not seen in reality. Special properties of the chitosan material may burden its way of application. Unlike the usual practice of only applying chitosan to material surface, our technology enables unique textile structure to have the advantages of chitosan while preserving the highly flexible textile structures; it can be applied in daily and protective wear, building interior and furniture, filtration, sanitary products and cosmetics, to name a few.




Chitosan as treatment and blended fibre in fabric (left) and mode of action by chitosan on bacteria (right)

## Novel Ferroelectric films for high-performance logic-in-memory electronics

This innovation pioneers in tailoring the 2D ferroelectric structures by precise phase engineering, via defect and strain control. Compared with traditional molecular beam epitaxy (MBE) and metal organic chemical vapor deposition (MOCVD) technology, this new technology is cheaper, faster, safer, and more efficient, which can obtain larger size films over centimetre (cm)-scale with controlled phases. The obtained $In_2Se_3$ films by our technology possess high electron mobility (29 and 53 $cm^2$ V-1s-1 in reverse sweep for β′- and α-$In_2Se_3$, respectively), and β′-α $In_2Se_3$ hetero-phase junctions have even higher non-volatile memory properties. The large-area ferroelectric films and in-plane ferroelectric hetero-phase junctions can be applied in the semiconductor industry for high-performance logic-in-memory electronics.



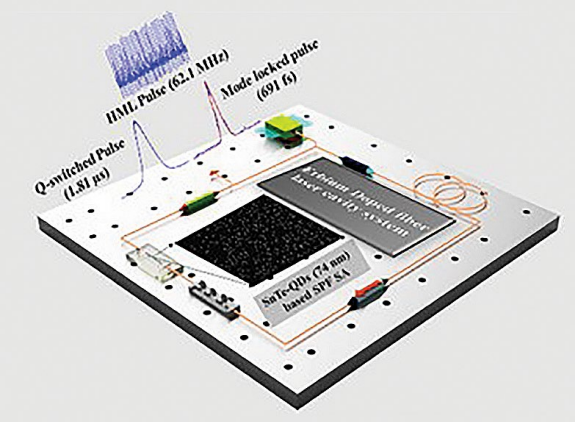

Phase-controlled synthesis of large-area 2D $In_2Se_3$ films.

a, Schematic diagrams of the controlled synthesis of β-, β′-, and α- $In_2Se_3$ films. The β and β′ phases were directly grown by VCVD and the α phase was obtained by phase transition after transfer β′ to non-flat substrates.

b, Photo of the obtained large-area $In_2Se_3$ films of three phases (β and β′on mica, α on PET).

## Nonlinear Optical Materials for Mode Locked Ultrafast Laser Generation

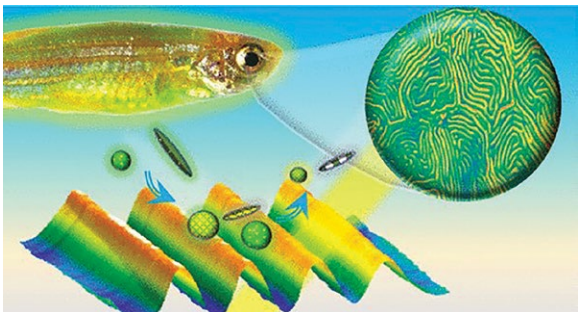
This innovation is a facile and lost-cost way to generate ultrafast laser using 2D material: ultrafast laser means a short pulse laser whose pulse width is usually picosecond to femtosecond, it usually relies on mode-locking technology to generate continuous ultrashort pulses. By utilizing novel two-dimensional materials having nonlinear optical properties as saturable absorber, the generation of ultrafast laser are facilitated. This patented technology has great potential to replace the generally high-cost and single-wavelength semiconductor saturable absorber to trigger ultrafast lasers. This innovation has a range of applications, such as laser surgery, communication, laser engraving, defence sector and scientific research.




Ultrafast laser generation using Tin-Telluride QDs Saturable Absorber (SA)

## Transparent Anti-Fouling Film

Polymeric surface with nanoscale wrinkles to reduce biofouling and maintain optical transparency: as submerged marine surfaces are quickly colonized by microorganisms, and may be attached by larger-scale animals such as mussels, barnacles and tubeworms, to keep the surface needs transparent for optical applications, the biofouling problem must be solved. Our innovation uses nanoscale wrinkles onto a polymeric film to efficiently reduce biofouling while keeping the surface optical transparency at a high level. It has the potential to be applied onto underwater cameras and sensors, as well as any surfaces that needs to be kept transparent and free from fouling, such as surgical cameras to facilitate visualization during intra-operative imaging.



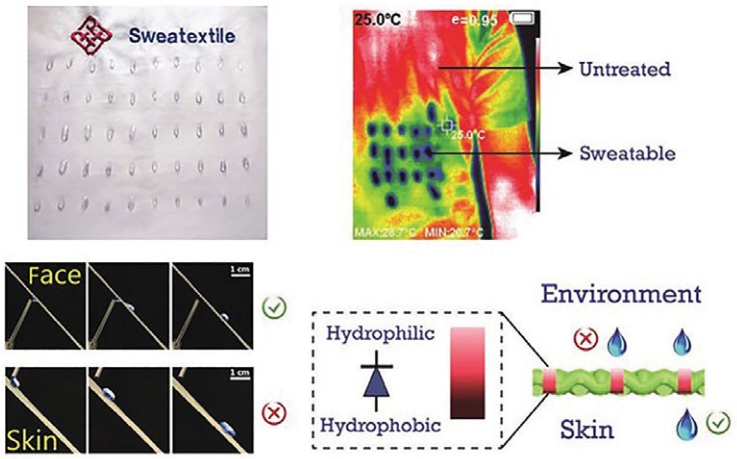
Inspired by the corneal surface of zebrafish (Danio rerio), experimental and numerical analyses demonstrate that a good compromise between optical transparency and antifouling efficacy can be achieved by wavy nano-wrinkles with a characteristic wavelength of 800 nm and an amplitude of 100 nm.

## Antivirus 3D Printing Material

Antivirus3D™ is a novel anti-virus 3D printing material that can kill the COVID-19 virus on surfaces as well as most common viruses and bacteria. The main component of the material is resin, added with anti-viral agents such as cationic compounds, to damage the membrane of the virus and destroy its structure to kill the virus and bacteria. Using 3D printing technology, it can be produced in different forms catering to different needs, a typical use is handle. After use on handle of recycling bin for a year, not only is the handle still in good condition, no COVID-19 virus, Escherichia coli and Staphylococcus aureus are detected on the handle's surface. This proves that the efficacy rate of the material only diminishes gradually after three years of use, and is effective in fighting against viruses and bacteria. Since the material kills viruses via physical means, it can still exert the same effect on mutant viruses.

## Sweatextile: A Nature-Inspired Textile of Unidirectional Water Transport and Dissipation for Moisture Management, Comfort and Protection (TechConnect Innovation Award)

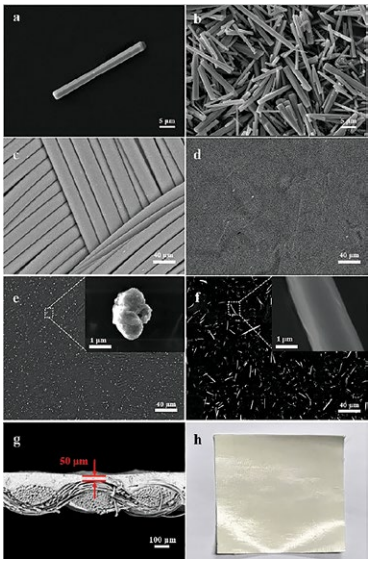
A new textile material to keep wearer cool and comfortable: when human body produces excessive sweat, the clothing will be soaked and clammy, affecting comfort and lowering physical performance with the body required to consume extra energy for sweat management. Beyond existing wicking textiles, the Sweatextile adopts a nature-inspired innovation, quickly directing and dissipating excessive sweat as water droplets to the outer surface, keeping one dry, comfortable, and having more energy and endurance. This innovation can benefit a wide arrange of consumers such as outdoor enthusiasts and highly-active professionals - including athletes, medical personnel, construction workers and firefighters.




Directional draining of water by Sweatextile

## Solar Heat Shielding Using Micro-Hair from Saharan Silver Ant

PolyU developed a new functional architextile by mimicking the amazing Saharan silver ants (SSant)'s ability to keep cool under extremely hot conditions. Unique hexagonal zinc oxide (ZnO) microrods (MRs) were rationally synthesized and further coated on polyester fabric with polydimethylsiloxane (PDMS) to achieve a bionic solar heat shielding architextile. The surface temperature of the as-prepared fabric can be lowered by 10°C compared to the control sample under the irradiation of a solar simulator of AM 1.5 G condition for 1 h. The as-synthesized coating material can reflect nearly 90% of the solar irradiance and thus leads to an efficient reduction in temperature. Additionally, the thermal conductivity and transmittance of fabric are also significantly enhanced after the coating process. This bionic coating material possess similar thermal shielding functions of SSant hairs and can have a potential application in developing solar heat shielding architextile.



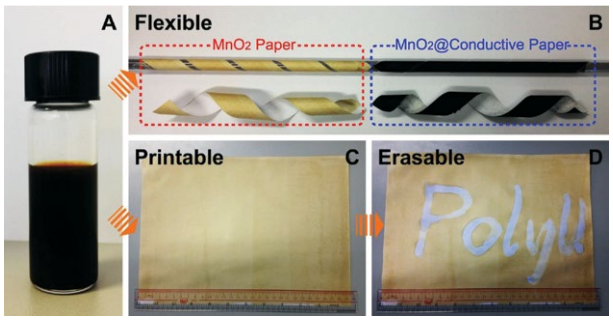
a) & b) SEM image of ZnO Microrods
c) PET fabric at front view,
d) PDMS-coated fabric at front view,
e) ZnO microparticles/PDMS coated fabric at front view,
f) ZnO microrod/PDMS coated fabric at front view,
g) ZnO fabric at cross-section view, h) photograph of ZnO fabric.

## Composite Multilayers Capacitors with Colossal Permittivity Materials for Electronics and Energy Storage Applications

Materials with colossal permittivity (CP) have shown great technological potential for advanced microelectronics and high-energy-density storage applications. Surface hydroxylated ceramic fillers, embedded in copolymer matrix can achieve high dielectric constant and exceptional low dielectric loss over a broad frequency range, as well as high energy density. The host oxides used in this CP system is friendly to the environment, non-toxic and abundant. Additionally, the process developed is relatively simple, low cost and suitable for mass production-scale. Compared to the conventional ceramic materials, these composites in this work are lightweight, scalable and easily fabricated into complex shapes towards miniaturization of the compact systems. The additional flexibility feature of them also possesses broad application prospects in modern electronic and energy storage devices.

## High Performance Printable MnO2-based Energy Storage Devices

This innovation is a printable and high-performance energy storage device comprising $MnO_2$-based electrodes and ionogel electrolyte: Printable electronics is of great interest in the areas ranging from thin film transistors (TFTs), energy storage devices, solar cells to micro electro-mechanical systems (MEMS). Conventional $MnO_2$ electrodes are mainly prepared by two approaches: (1) nanostructured $MnO_2$ or $MnO_2$-containing composite precipitates via wet chemical process; (2) direct electrodeposition or chemical deposition on various substrates (e.g. glass, quartz, copper or aluminium foil). These existing preparation methods suffer from high cost, complicated process and superfluous contaminations, the introduction of insulating binders would also cause agglomeration in the inks, leading to the reduction of electrical conductivity. In our innovation, the $MnO_2$-based electrodes could be prepared on various substrates by inkjet printing process without any binder. As a result, continuous and semi-transparent $MnO_2$ thin films were obtained on the commercially available fluorine doped tin oxide (FTO) glass and served as the electrode for symmetric supercapacitor. The as-prepared device exhibited a maximum specific capacitance of 86 F·g-1at 0.1 F·g-1, leading to a superior energy density of 38.75 Wh·kg-1. All the merits make the $MnO_2$-based energy storage devices a promising candidate for large-scale production of printable and high-performance electronics in the near future.

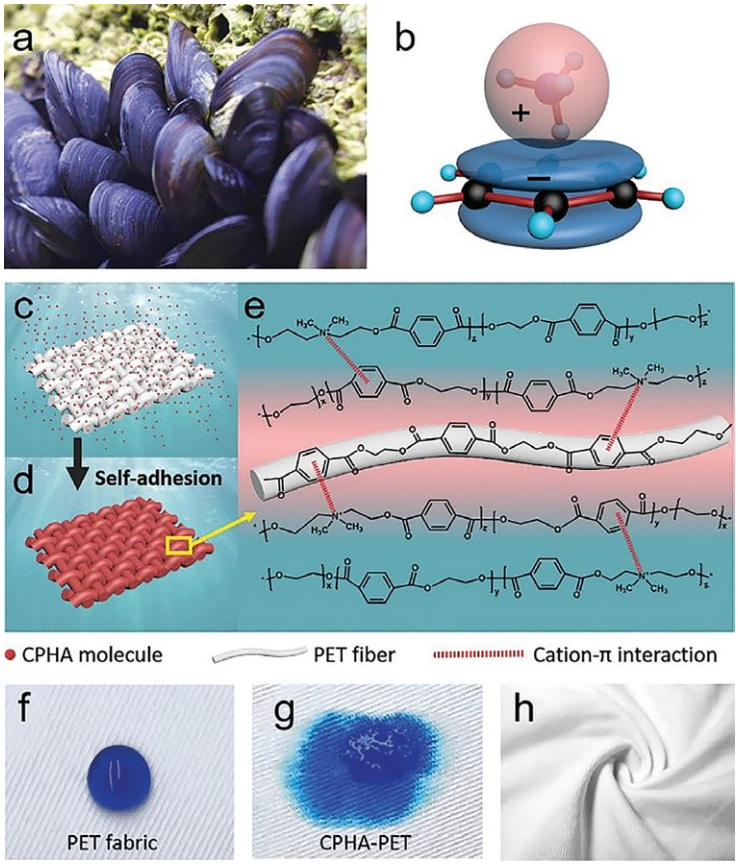



(A) Optical picture of the $MnO_2$ ink.
(B) $MnO_2$ ink coated flexible paper strips with (right) and without (left) MCNTs treatment.
(C) A sheet of A4-sized paper coated by the $MnO_2$ ink.
(D) The $MnO_2$ coated paper shown in C erased by oxalic acid with the erased area showing the word "PolyU".

# Bio-Inspired Super-Hydrophilic Polymer C-Pip for The Modification of Polyester Fibre

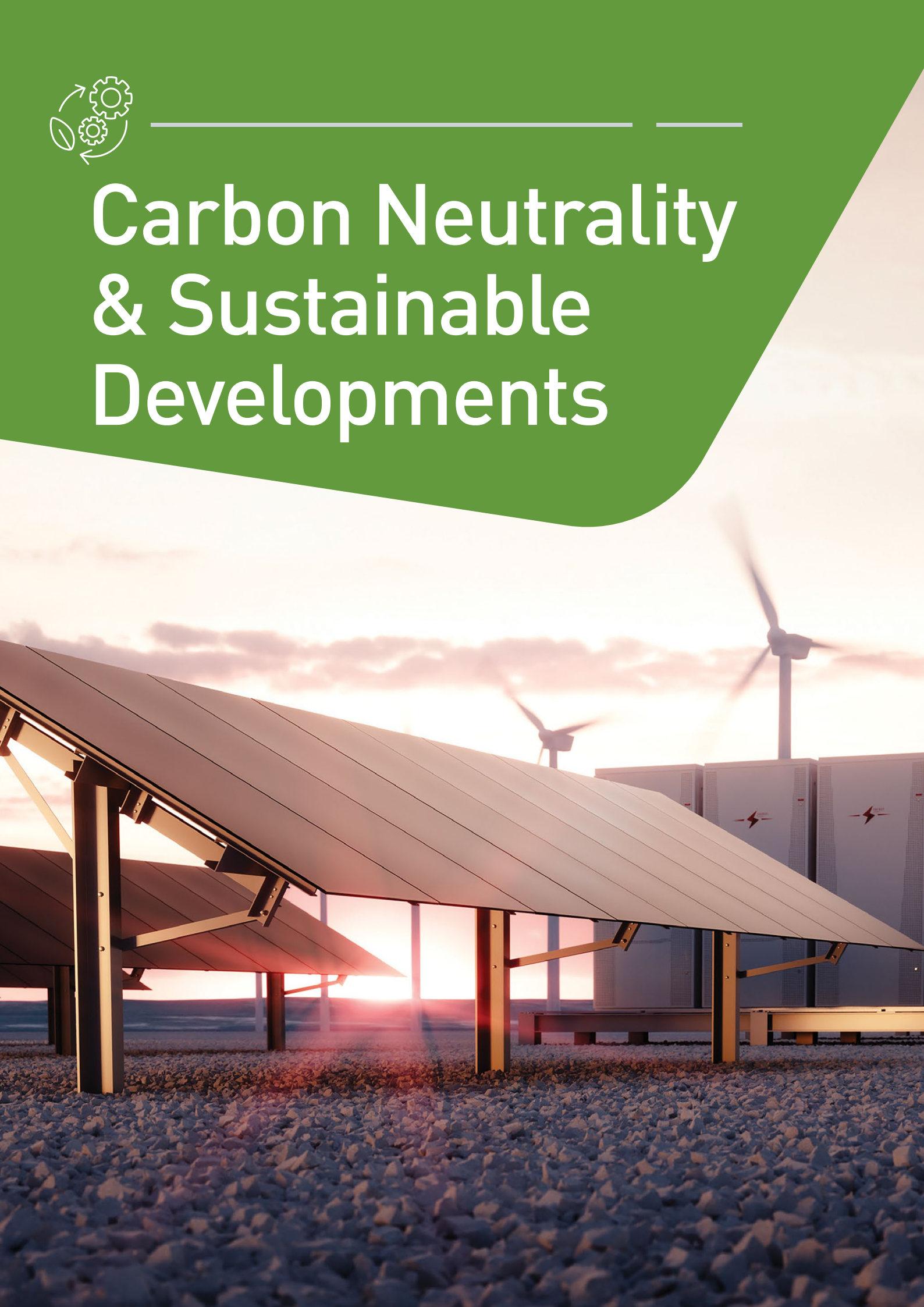
Inspired by the strong underwater adhesion properties of mussels, a new and novel superhydrophilic polymeric molecule C-PiP has been developed with strong cohesion and adhesion property on polyethylene terephthalate (PET) fabric. During the wet application process, the cations serve as a vanguard to breach the hydrated ion layer on the PET fibre surface, allowing the facile self-adhesion of C-PiP on the PET surface without the need of any auxiliary that potentially pollutes the water resources when discharged.

Meanwhile, the new polymer can efficiently transform the hydrophobic PET fabric to a cotton-like absorbent material. Taking advantage of its strong adhesion, C-PiP targets polyester fabrics to achieve controllable one-way sweat transport to keep skin dry and comfortable, while the anti-microbial property of C-PiP provides a hygienic solution to wearers. This innovation can be potentially applied in polyester-based products, especially for sportswear, underwear, uniforms, as well as other functional textile products.



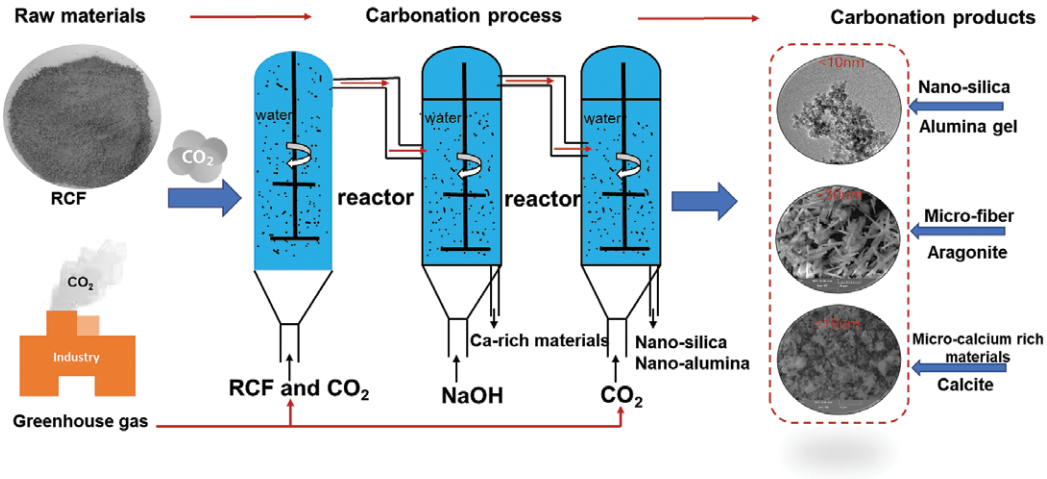

a) Photograph showing the mussels attached on the rocks (photograph by Cianke (CC0)).
b) An illustration of the cation–π interactions.
c–e) An illustration of the aqueous textile finishing process using CPHA.
f, g) Photographs of pristine PET (f) and CPHA finished PET (g) after deposition of an ink droplet.
h) Photograph of PET after CPHA finishing with good static drape and whiteness.

# Carbon Neutrality & Sustainable Developments



## Rapid Carbonation Technology for Waste Concrete

The world is facing a critical environmental challenge due to the extensive release of $CO_2$. Cement and concrete industry being one of the biggest carbon emitters, is responsible for 8.6% of global anthropogenic $CO_2$ release. In China alone, about 23.6 billion tonnes/year of this waste was produced. The fine recycled concrete fine (RCF) is the by-product produced from the recycling process of construction and demolition wastes, which possessed around 20% of waste concrete, worse still, most RCF is normally disposed of in landfills. We address these issues to have the waste concrete converted to be carbon sink by our rapid carbonation technology. The high value-added products such as nano-silica and micro-fibre were successfully developed by from incineration bottom ash and concrete slurry waste, effectively solving the landfill and secondary pollution of fine recycled concrete. Meanwhile, a large amount of $CO_2$ was permanently stored during the process (~ 0.2-0.3ton/ton recycled concrete fine).




The diagram of preparation of nano-silica and microfiber using waste concrete and flue gas

## Personalized Thermal-Comfort Platform for Smart Building (TechConnect Innovation Award)

Heating, ventilation and air-conditioning (HVAC) system accounts for more than half of building energy consumption and leads to huge energy wastes. A Scalable Personalized Thermal-comfort (SPET) platform, which includes standardized data schema and SDK with adapters to harvest data of smart hardware and proactively guide building automation systems temperature setting services, analytic framework that optimize thermal comfort and energy conservation and visualization software package to show the thermal comfort of buildings, has been developed to quantitatively estimate the thermal comfort of any individual occupants or groups in daily operations.

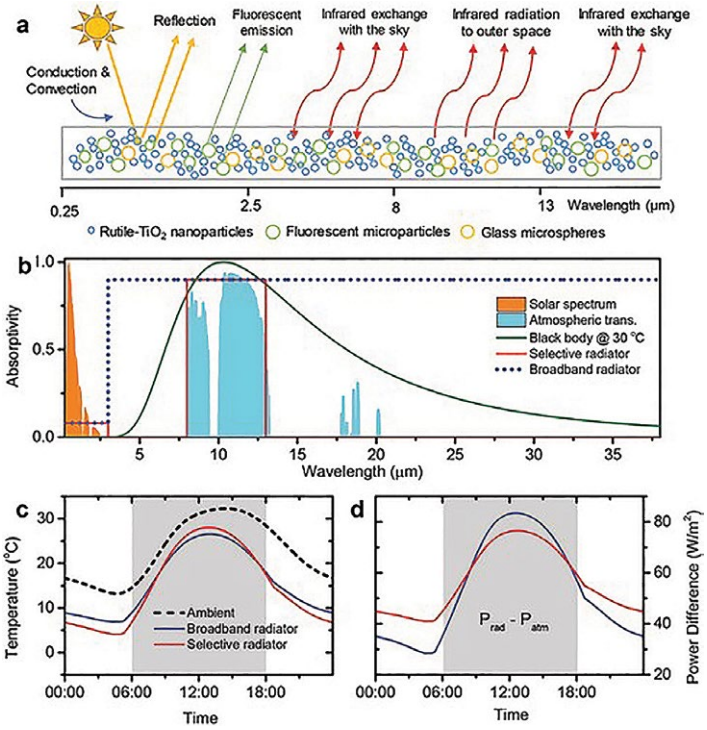
The research results have shown a preliminary version of the model can save energy for 18% and improve thermal comfort for 33.8%. SPET can benefit three industry sectors: 1) smart energy systems for buildings and homes; 2) provides new meanings of data to smart personal devices and smart hardware; and 3) provides top up services for building automation and services.

## A Fully Solar-Powered Standalone Membrane Distillation System for Fresh Water and Power Supply

A novel fully solar powered stand-alone membrane-based desalination system is developed to provide flexible fresh water and DC/AC power for remote households without reliable infrastructure, such as offshore islands and remote inland communities. In the system, a solar PV/T array is installed to provide both thermal energy and DC power respectively together with a smart power station and phase change material (PCM) thermal storage tank; in addition, a membrane-based desalination technology is adopted with a novel membrane module.

## An Eco-Friendly Smart Coating to Keep Buildings Cool Without Air Conditioners

PolyU developed a method to upgrade the conventional building-coating materials with a peculiar self-adaptive cooling effect through combining particle scattering, sunlight-excited fluorescence, and mid-infrared broadband radiation: unlike sub-ambient daytime radiative cooling (SDRC), though being a promising electricity- and cryogen-free pathway for global energy-efficiency, has stringent surface designs are neither cost-effective nor eco-friendly. When exposed to direct sunlight, our innovative coating can achieve 6°C below the ambient temperature under a solar intensity of 850 W/m$^2$, yielding a cooling power of 84 W/m$^2$. This cost-effective approach opens a totally new avenue in broadening the technology into various applications in buildings, infrastructures, automobiles, pavements, communication stations as well as functional textile materials for personal cooling.




a) Schematics of the cooling mechanism of the designed coating.
b) Standard solar spectrum, IAM1.5(λ) (orange), transmittance spectrum of the atmosphere, tatm (λ) (cyan), black-body radiation spectrum at 30°C, B (λ, 30°C) (green), ideal absorptivity spectra, ARC(λ) of a selective radiator (red) and a broadband radiator (blue).
c) Cooling temperatures for the broadband radiator (blue) and the selective radiator (red), in comparison with the measured ambient temperature (black).
d) Calculated Prad – Patm for the broadband radiator (blue) and the selective radiator (red).

## Multi-functional Transparent Nano-Coating for Glass

A novel long-term glass multi-functional layer is developed by uniform coating nanoscale $TiO_2$ and antimony doped tin oxide (ATO) mixture particles as the main material on various glasses. The $TiO_2$ nano-particles are synthesized by low-cost hydrothermal method while the ATO by high-temperature calcination technique.

This coating is featured by super-hydrophilic self-cleaning property, thermal insulation property and photocatalysis property. With contact angle of less than 5°, the coating can block over 70% IR/90% UV light but transmits more than 70% of visible light. It can also break down organic pollutants. The innovation proposes a special formula from which water could be used as the dispersion medium of the precursor that could realize the good effect of no harm to human beings.

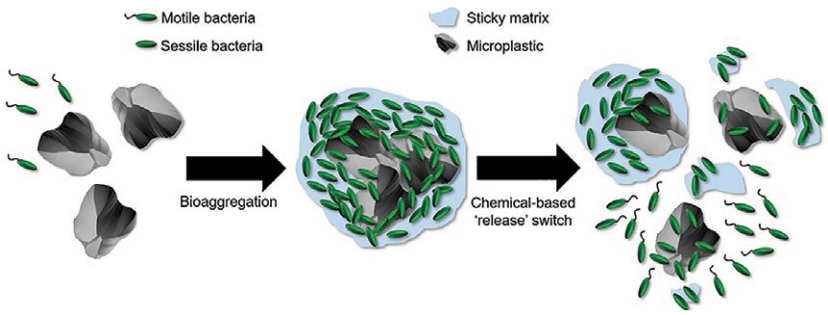
Glass coated with $TiO_2$ nanoparticles and ATO

## Micro Magnetic Driven Bidirectional Turbine for Hydropower Generation

PolyU devised a battery-free turbine with magnetic coupling for monitoring pipeline systems: as we know that water supply pipelines leakage monitoring systems are composed of sensors and meters usually empowered by chemical batteries, and need to be replaced from time to time, by applying magnetic coupling in the developed turbine, now we can monitor leakage and water quality without batteries and make water monitoring more reliable and continuous with this system, while reducing high cost and labour demand for battery replacement.

## Microbial solution for enhanced removal and recovery of microplastic pollutants

This technology provides a very efficient solution to remove hazardous microplastics. It is well known that microplastics pose serious threats to environment and wildlife. Conventional wastewater treatments via filtration or by alum salts/ acids can only remove 10-20% of microplastics from sewage, resulting in effluent release; other methods like microbial degradation of microplastics run the risk of releasing toxic substance to the environment. Our microbial solution with a 'capture-then-release' ability is the first low-cost method that removes 90% of microplastics by first bio-aggregating microplastics within its multicellular biofilms within 1 day, then, activating 'release' switch to release trapped microplastics from biofilms for downstream resource recovery after the retrieval of biofilm-microplastic aggregates. This solution can treat all types of microplastics of different sizes and compositions, including low-density microplastics and can be applied in varying environmental conditions, thus greatly improves the efficiency of removing microplastics and reduces the harmful effects of microplastics.




Schematic illustration of microbial 'capture-and-release' solution of microplastics pollution

## Lignocellulosic Biomass Treatment for Waste Management

This technology aims to fractionate high-value lignin from wastes derived lignocelluloses. The overall biomass conversion is conducted by mixing the biomass with 1,4-butandiol (BDO) in reactor operated under a sequencing batch reactor mode for pre-treatment, cellulose regeneration, and enzymatic hydrolysis. The regenerated substrate will be subjected to hydrolysis and the solvent in the spent liquor will be recycled.

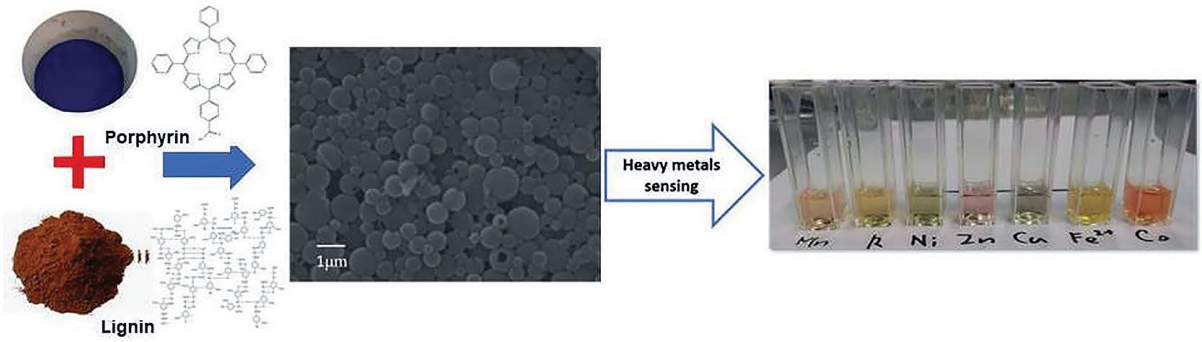
In comparison with other organosolv processes, BDO shows high feasibility to harvest reactive lignin (high solubility and favourable structure for downstream utilization) at high yield, which does not relate to the severity of pre-treatment. The reaction condition of the process is considered mild, which preserve the potential value of the dissolved lignin and hydrolysability of cellulose. The specific features of non-biomass specific, low operation pressure, and high yield make the process particularly suitable to be applied in highly populated cities for waste management.

## Green Nano-Polymer for Fast Screening of Heavy Metals

Porphyrin and its families are widely applied in various commercial products like chemical sensors, bio-imaging agents and cancer drugs. These products are usually applied with synthetic and petroleum-based polymers as the building block. During the incorporation with porphyrin, a complex procedure is involved while hazardous chemical reagents are always created.

In this prototype, a natural plant-based polymer (alkali lignin) is applied for incorporation with porphyrin. The biorefinery-derived lignin-porphyrin nano-polymer (lignin-TPP) demonstrated remarkable performance and contain outstanding feature which cannot be provided by the original chemicals alone. It can be served as a rapid sensor to detect different types of heavy metals via simple UV-vis spectroscopy (R2=0.99). In comparison with porphyrin, the emission intensity of lignin-TPP is significantly enhanced (>50 folds) in high-water fraction (>90%) environments with broad pH range. Therefore, it showed the potentials in bio-imaging application due to its stable and intense emission at a broad range of pH.

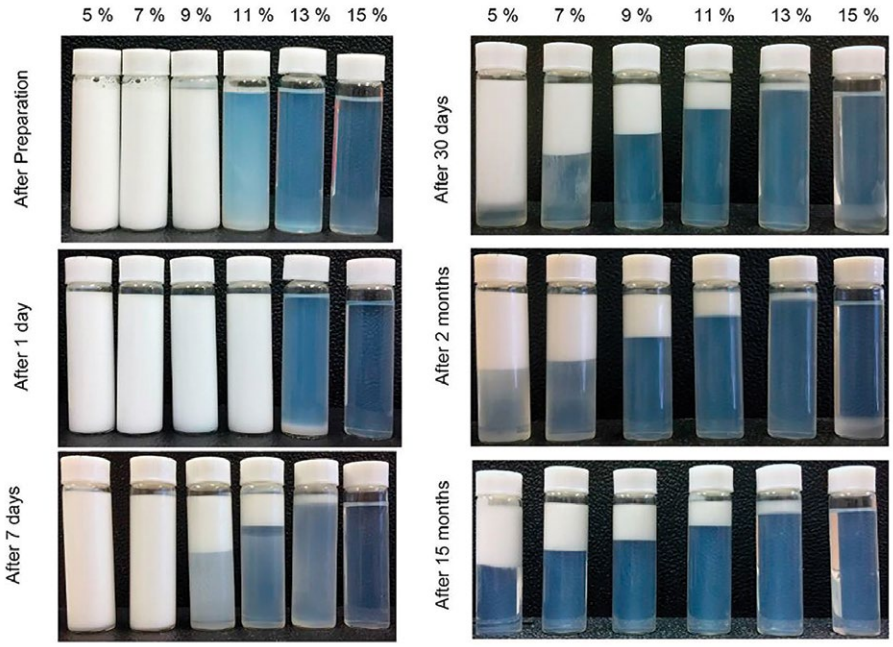
This technology demonstrated an example of effective utilization of lignin to fabricate a new functional material and offering significant benefits to waste valorisation industries.




Heavy metal sensing by Lignin-TPP

## High-Performance PCM Nano-Emulsions for Efficient Thermal Energy Storage

Thermal energy storage (TES) technology is developed to save and reserve the excess thermal energy from various sources for better utilization. Phase change materials (PCMs) are the media for storage of latent heat. The PCM nano-emulsion developed by PolyU is a homogeneous dispersion of nano-sized PCM droplets that can attain a more efficient heat transfer between the PCM droplets and the ambient fluid. Furthermore, it can be regenerated and reused for many heating-cooling cycles, retaining a long service life. As a homogenous and low-viscosity fluid, it can be readily transported through the TES system. With all these features, this innovation can be potentially applied in air-conditioning in active building systems, solar water heating and thermal management of batteries and electronics.




Photographs of the emulsion samples during the storage period. (Nano-emulsion samples with different concentrations of emulsifier were stored in stoppered 10 mL cylindrical bottles at room temperature).

## Electrochemical Water Splitting Catalysts with Nanostructure

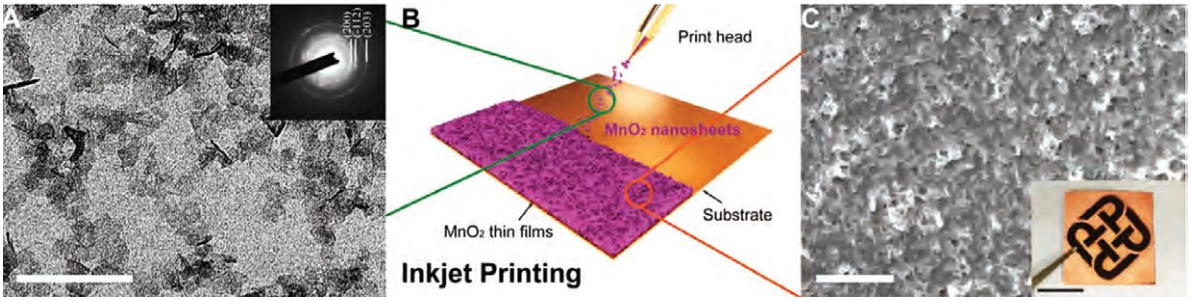
This innovation is a Pt-free catalyst plate for hydrogen production: hydrogen production by electrochemical water-splitting is a very promising method and a key technology for hydrogen fuel cell vehicles, however, conventional electrolysers for water splitting employ expensive catalyst such as Pt.

Our Pt-free catalyst hetero-structured CoP@a-CoOx plate consists of the embedded crystalline cobalt phosphide (CoP) nanoclusters and amorphous cobalt oxides (CoOx) nanoplates matrix for use as oxygen evolution reaction (OER) and hydrogen evolution reaction (HER). This composite material exhibits comparable activity with the traditional Pt-based catalyst but the use of Pt is reduced to zero, the developed catalyst exhibits good stability for hydrogen and oxygen production by water splitting.

The technology can be applied for hydrogen and oxygen production at large scale, which allow the use of excessive solar and wind power for hydrogen generation to support the hydrogen fuel cell vehicle development.

## Printable $MnO_2$ Based Rechargeable Sodium Batteries

High performance $MnO_2$-based battery inkjet-printed electrode: our inkjet-printed $MnO_2$ electrode serves as a cathode material for high performance rechargeable sodium batteries. The as-assembled full cell could reach maximum energy and power densities of 147 Wh·kg–1 total and 4.6 kW·kg–1 total with average working voltage of 2.3V and ca.100% capacity retention after 100 cycles, which could be anticipated for practical energy applications. The $MnO_2$-based electrode can achieve simultaneously and unprecedentedly a working voltage of 2.5V, maximum energy and power densities of 587 Wh·kg–1cathode and 75 kW·kg–1cathode respectively with a 99.5% capacity retention for 500 cycles at 1 A·g–1. These values are approaching the targeted sodium ion batteries. The long-neglected kinetically limitation effect is found to be effective in controlling the redox mechanism. The inkjet-printed $MnO_2$ electrode shows an enhanced redox activity of $Mn_{4+}/Mn_{3+}$ coupling, along with a fully suppressed redox activity of $Mn_{3+}/Mn_{2+}$ couple. Owing to the earth-abundant and low cost of sodium (Na) as compared to Li, sodium secondary batteries are envisioned to be a viable alternative to replace the current lithium (Li)-based battery industry.

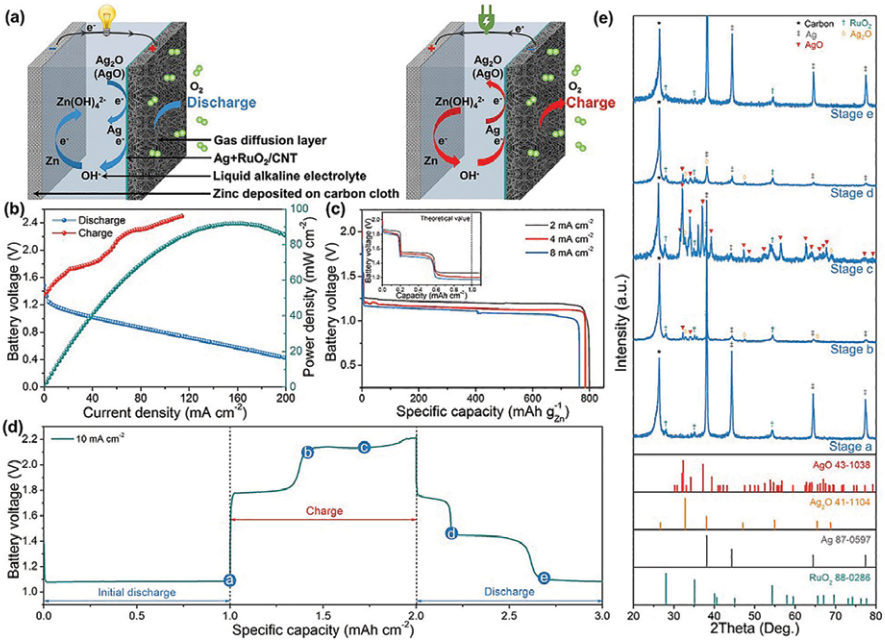



Systematic illustrations of the $K0.3MnO_2$ electrode.
A) Surface view of the TEM image. Scale bar is 100 nm. Inset: the corresponding SAED pattern.
B) Schematic diagram of the inkjet printing process.
C) Surface view of the SEM image. Scale bar is 2 μm. Inset: A patterned electrode.

## Zn- Based Hybrid Batteries for Flexible Electronics

Existing batteries show poor efficiency due to high charge voltage and low discharge voltage. PolyU has developed a new technology which perfectly integrates the advantages of both Zn-air batteries and Zn-metal batteries. By developing nano-structured Zn-electrode and Ag-RuO /carbon nanotube air electrode or Co O / carbon cloth air electrode, it can successfully increase the discharge voltage and decreases the charge voltage, leading to higher efficiency (over 70%) and higher discharge voltage (>1.8V) than existing Zn-air batteries. In addition, the Zn-dendrite formation is significantly minimized, leading to excellent cycling stability. By replacing the liquid electrolyte by the gel electrolyte, we developed flexible Zn-air batteries for powering flexible electronics.

This hybrid battery is more efficient, durable, cheaper, and safe for use. It can be applied in various electronic devices, such as power sources for portable electronics (mobile phones, notebook, digital watches) and wearables.



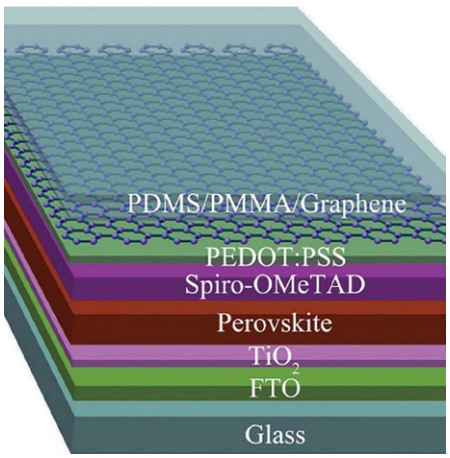

Electrochemical evaluation of the liquid electrolyte-based hybrid battery.
(a) Scheme of the battery structure with proposed electrochemical processes during discharge and charge.
(b) Discharge and charge polarization and the corresponding power density.
(c) Galvanostatic discharge profiles at the current densities of 2, 4, and 8 mA cm–2 after charge polarization, the inset shows the initial voltage profiles.
(d) Initial discharge–charge–discharge voltage profiles at 10 mA cm–2.
(e) XRD patterns of the electrode at different states.

## Graded Silicon-Based Electrode for Lithium-Ion Batteries

This technology tackled delamination problem in lithium-ion battery electrodes by re-allocating the silicon nanoparticles in a layer-graded way. The resulting graded electrodes exhibited much better electrochemical performance and higher utilizing efficiency of silicon in comparison with the homogeneous controls containing the same amount of constituent materials.

## Highly Efficient Semitransparent Perovskite Solar Cells

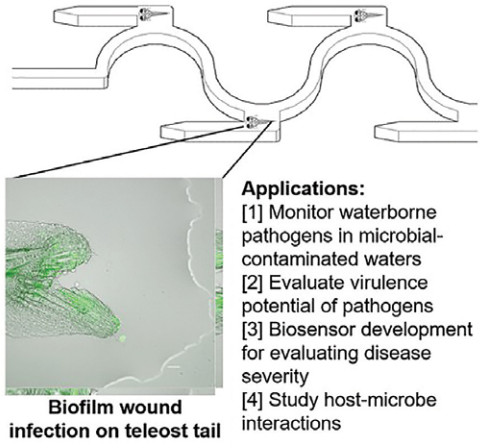
Developing transparent or semi-transparent solar cells with high efficiency and low cost has become increasingly important due to the increasing demands of the building integrated photovoltaics (BIPVs) systems. PolyU has developed efficient and low-cost semi-transparent perovskite solar cells with graphene electrodes. The power conversion efficiencies (PCEs) of this novel invention are around 12% when they are illuminated from fluorine-doped tin oxide (FTO) bottom electrodes or the graphene top electrodes, compared with 7% of conventional semi-transparent solar cells. The semi-transparent feature enables it to absorb light from both sides, and can be widely used in windows, facades, louvers and rooftops of buildings for converting solar energy into electricity, thus increasing the surface area for collecting solar energy substantially.




Structure of transparent perovskite solar cell

## MicroFish: Microfluidic platform for microbe-fish infection models

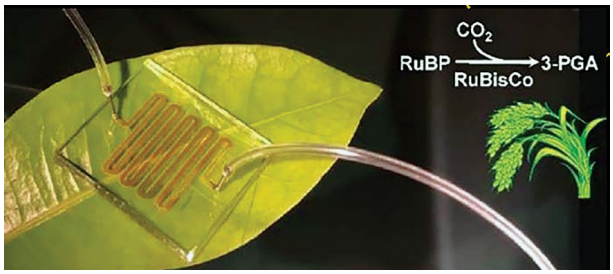
MicroFish provides an excellent pathogen monitoring and assessment tool, is a rapid, palm-sized high-throughput microfluidic-based device that simultaneously monitors waterborne pathogens in contaminated waters and assesses their infection potential under well-defined settings. The fish animal is cultivated in the chamber, where pathogen-contaminated water samples will be flowed through the chamber for fish infection, such as wound and gill infection. A chamber-associated port allows direct access to the animal, while the transparency of the device enables clear observation of microbial colonization and sensor readouts. The MicroFish platform can be readily applied to various fish species and microbes to assess microbial and chemical risk in aquatic bodies in resource-constrained settings.




The MicroFish platform. The microfluidic device enables the flow of small volume of water samples into chambers containing teleost (fish) animal, allowing the waterborne pathogens to colonize and infect the animal.

## Artificial Photosynthesis of Carbohydrates Using Microfluidic Chip

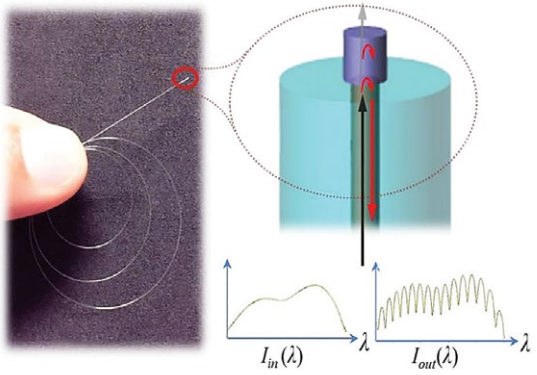
It is well known that the production of carbohydrate relies on natural photosynthesis in green plants. However, its energy efficiency is low due to the low activity and poor specificity of the first and most abundant enzyme D-ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCO) in green crops. To mimic natural photosynthesis with greater energy efficiency, this novel method is developed to immobilize the RuBisCO enzyme inside a microfluidic reactor, thereby facilitating the continuous production of the glucose precursor from $CO_2$ with high efficiency and high stability. This innovation represents a major advancement towards the artificial photosynthesis of basic food materials and may provide a potential solution to food shortage problem.




Mimicking photosynthesis, artificial synthesis of carbohydrate realized from Co2 using RuBisCO via microfluidic reactors.

## Optical Fiber-Top Microcavity $CO_2$ Sensor

PolyU has devised a miniature fibre-optic $CO_2$ sensor by in-situ printing of a special polymer Fabry-Pérot (FP) microcavity on the end facet of standard single-mode optical fibre. A photo-crosslinkable poly (ionic liquids) (PILs) with high $CO_2$ adsorption capability has been developed to fabricate the polymer optical microcavity via an optical 3D μ-printing technology. Experimental results show that such an optical $CO_2$ microsensor has very high sensitivity and fast response and thus is very promising for environment and exhaust gas monitoring applications.

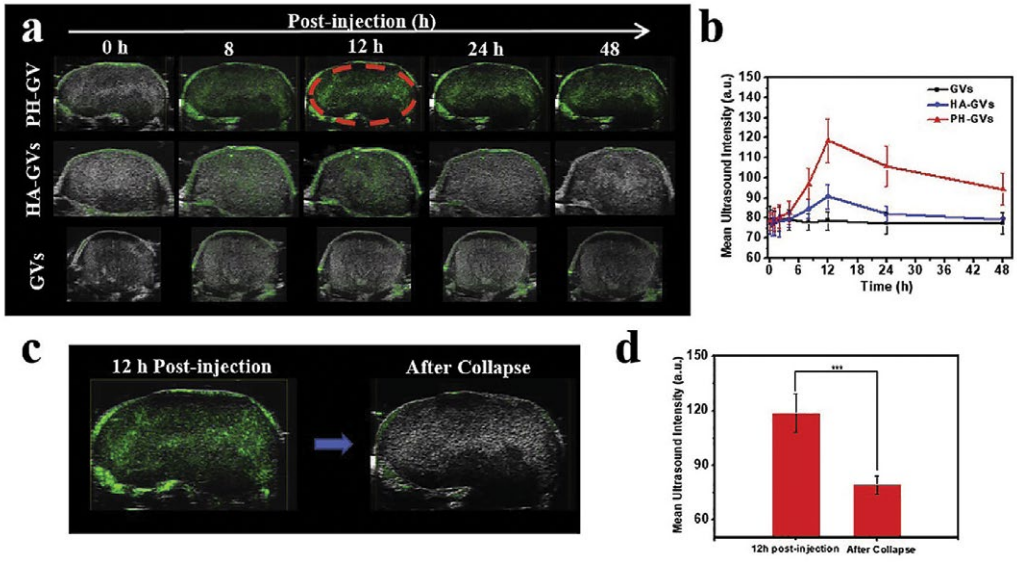



Schematic diagram of the optical fiber end-face microcavity $CO_2$ sensor and the spectra of the sensor's input and output

# Biomedical and Chemical Engineering

## Multi-Functional Gas Vesicles for Enhanced Cancer Therapy

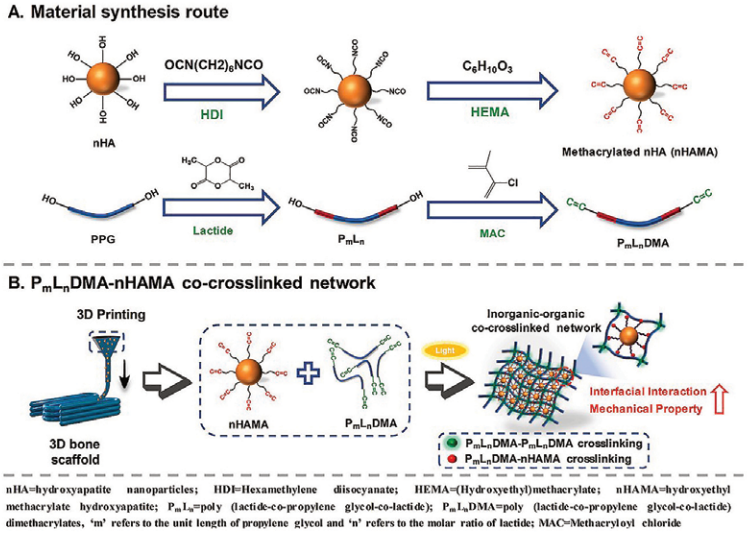
Gas vesicles (GVs) are the first biomolecular acoustic reporters with gene editability and inherent stability. GVs could facilitate the occurrence of cavitation and can potentially enhance the efficacy of sonodynamic therapy. In this innovation, multi-functional GVs through surface modification was developed for the purpose of enhancing cancer therapy. In particular, our PEGylated HA-GVs have shown to have high tumour-targeting efficacy, which can serve as a molecular ultrasound probe for in vivo tumour detection, and lipid-GVs could function as an oxygen carrier that could deliver large quantity of oxygen to the tumour site to alleviate tumour hypoxia. Modified GVs have great potential in the future of cancer treatment.




Ultrasound imaging of PH-GVs in tumour sites. In vivo ultrasound images of tumour after intravenous injection of GVs, HA-GVs and PH-GVs were captured. Representative images are shown in (a) with quantification of intensity shown in (b). The green colour represents the intensity-enhanced region due to the GVs. (c) Vesicle collapse with destructive insonation (650 kPa). Representative images are shown in (c) with quantification of intensity shown in (d).

## Biomimicking Photocrosslinkable Nanocomposite Bone Graft

A novel photocrosslinkable nanocomposite bone graft is developed by mimicking the natural bone structure. With this technology, surgeons can premade, trim and directly apply the nanocomposites during bone graft operations according to patients' needs, thereby greatly reduce the bedridden time. This innovation serves as a huge number of patients receiving orthopaedic surgeries, such as for craniomaxillofacial, dental, foot and ankle, as well as joint reconstruction, long bone and spinal fusion.




Schematic illustration of
(A) synthesis route of photocrosslinkable nanocomposites consisting of PmLnDMA and nHAMA, and
(B) 3D printing of bone scaffolds with PmLnDMA/nHAMA nanocomposites.

## New Antibiotic Candidates to Treat Superbug-Caused Inflection (TechConnect Innovation Award)

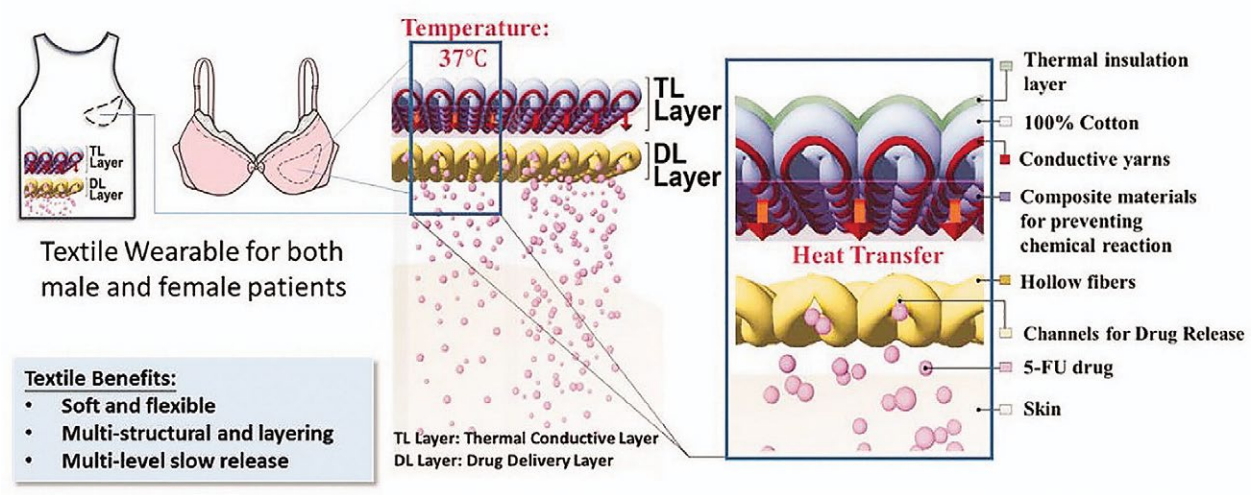
New antibiotic-resistant-bacteria-targeting drugs that are benign to human cells: through the research of bacterial transcription system, new antibiotic drug candidate was discovered. Unlike current antibiotics in the market, these first-in-class antimicrobial small molecules with new mechanism of action displayed excellent bactericidal effects against bacteria including antibiotic-resistant pathogens.

These molecules target the important bacterial protein-protein interactions not existing in mammals, therefore demonstrated no toxicity to human cells, while the pre-clinical studies are ongoing. These new antibiotic drug candidates are expected to be developed to complement the current antibiotic drugs for treating bacteria caused infectious diseases and contributing to the society and healthcare system threatened by antibiotic-resistant bacteria.

## A Functional Textile-based Thermal-stimuli Drug Delivery Apparel System

Fibre technology has become increasingly essential in various industries, such as the fashion clothing, medical, cosmetic and upholstery industries. It can be used to overcome some existing challenges of textile–skin interaction in response to medical functions. This innovation is the result of studying the thermal-stimuli effects and biological performances of drug delivery textiles and developed a personal self-care textile that is wearable for a wide range of adaptive medical treatments.

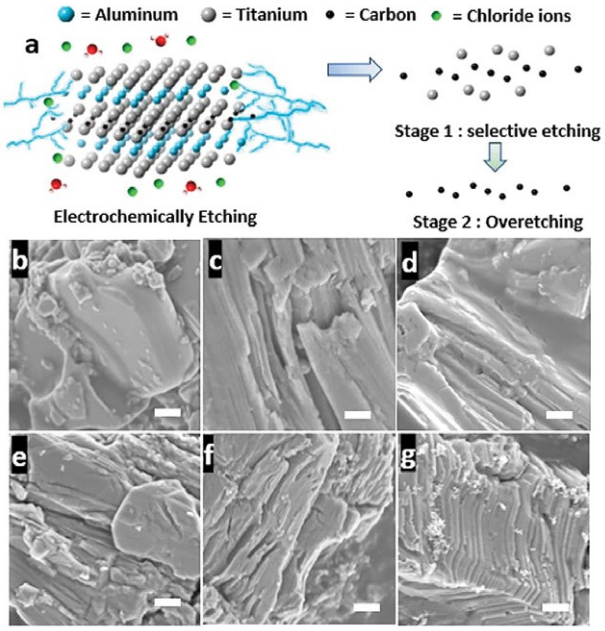
Silver-coated conductive yarns were fabricated into hollow fibre-based non-woven fabrics for thermal stimulation. Significant drug delivery through the non-wovens is shown by the anti-breast cancer analysis. Drugs in different phases, liquid and crystal solid, could be carried by the lumens of the hollow fibres. This innovation can be potentially commercialized, and will be a great technological breakthrough in preparing a future generation of drug delivery medical textiles. A variety of medical applications can hence be provided and it could also be an alternative for topical healthcare.




Thermal-stimuli drug delivery self-care wearable textile. The textile wearable, which consists of the thermal conductive e-fabric layer and the drug delivery layer, provides a convenient and comfortable medication for breast cancer patients. 5-FU: 5-fluorouracil.

## HF-Free Facile and Rapid Synthesis of Mxenes Related Materials and Their Efficient Energy Conversion and Storage Applications (TechConnect Innovation Award)

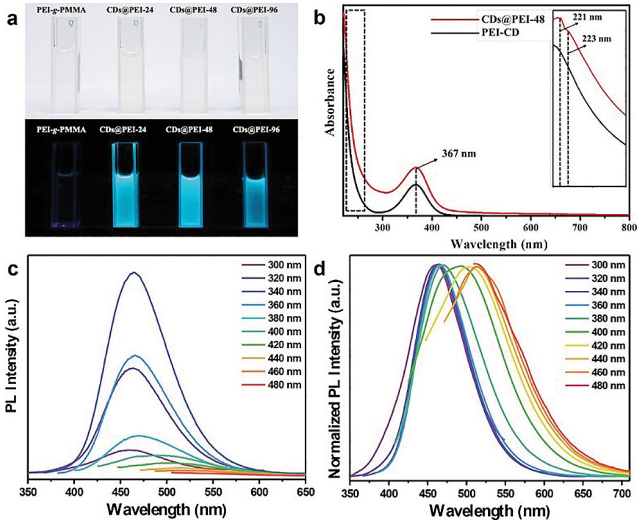
Synthesizing MXene without involving Hydrofluoric Acid: MXene has widespread applications in electrochemical energy storage and bio-imaging due to its high robustness and non-toxicity. However, traditional toxic synthetic routes require the use of extremely toxic hydrofluoric acid (HF) to synthesize MXenes which raises considerable safety and environmental concerns. To overcome this problem, a HF-free electrochemical method is developed to synthesize MXenes. The resulting MXenes exhibits stable and highly efficient energy storage, offering promising applications towards fast-approaching raised energy crisis and demands.




Etching mechanism and morphological studies of Ti2CTx.
(a) Proposed E-etching mechanism of Ti2AlC in HCl electrolyte. SEM images of Ti2CTx produced from different E-etching conditions ([HCl]/temperature/time/voltage).
(b) Unetched Ti2AlC,
(c) 1 M/25°C/9 h/0.3 V,
(d) 1 M/50°C/3 h/0.3 V without CB,
(e) 1 M/50°C/3 h/0.3 V, (f) 1 M/50°C/6 h/0.3 V, and
(g) 1 M/50°C/9 h/0.3V. The scale bars are 1 μm.

## Water Dispersible Auto-fluorescent Polymer Dots Comprising of Non-Conjugated Polymers

This new type of photoluminescent nanoparticles utilize inexpensive non-conjugated polymers as building blocks, and has the ability to display ultra-bright and multi-colour fluorescence upon excitations in both water and dry states. It has various potential applications, including serving as bioimaging markers for in vitro cell imaging; auto-fluorescent nano-carriers for image-guided therapy, nanofillers in plastics for LED diffuser applications, fluorescent ink in anti-counterfeiting applications, as well as chemosensors for heavy metal detection and structural health monitoring.




a) Photos of PEI-g-PMMA nanoparticles and CDs@PEI particles under room light and 365 nm UV irradiation;
b) UV–vis spectra of both CDs@PEI particles and control PEI-CD nanoparticles;
c) PL spectra of CDs@PEI-48 particles under different excitation wavelengths;
d) normalized PL spectra of CDs@PEI-48 particles under different excitation wavelengths.

## Rapid Detection of Drug-abuse and Edible Oil authentication by Mass Spectrometry

Conventionally, drug analysis typically involves preliminary screening, followed by confirmatory analysis. However, the preliminary screening has the problem of producing false positive or false negative results, while the confirmatory analysis is time-consuming and laborious.

To address these problems, PolyU has developed 2 techniques, i.e., wooden-tip electrospray ionization mass spectrometry (WT-ESI-MS) and solid phase microextraction coupled with electrospray ionization mass spectrometry (SPEM-ESI-MS), for rapid and reliable detection of drugs-of-abuse. WT-ESI-MS allowed detection of common drugs-of-abuse in urine and oral fluid with analysis of one sample within minutes, while SPME-ESI-MS allowed detection of drugs-of-abuse in urine and oral fluid with higher sensitivity with time efficiency and high accuracy.

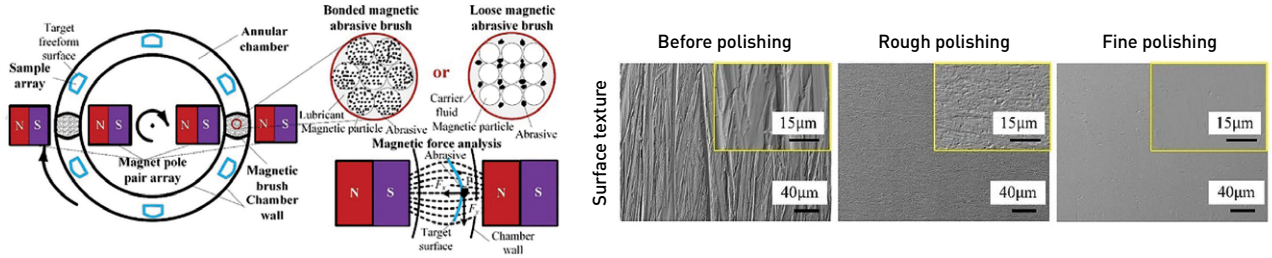
Similar technique can be used to detect edible oils, by using matrix-assisted laser desorption/ionization mass spectrometry (MALDI-MS) and establishing a preliminary spectral database of edible oils, since different types of edible oils have different MALDI-MS spectral patterns, the authenticity of an edible oil sample can be determined by comparing its MALDI-MS spectrum with those of its labelled oil in the established database.

Compared to conventional techniques, using MALDI-MS is much more time efficient and cost effective, as it only takes a few minutes without the need of sample extraction, derivatization, sample clean-up and separation. The technique can be used by the industry to authenticate edible oils and screen out mixed edible oils and recycled edible oils.

# Advanced Manufacturing

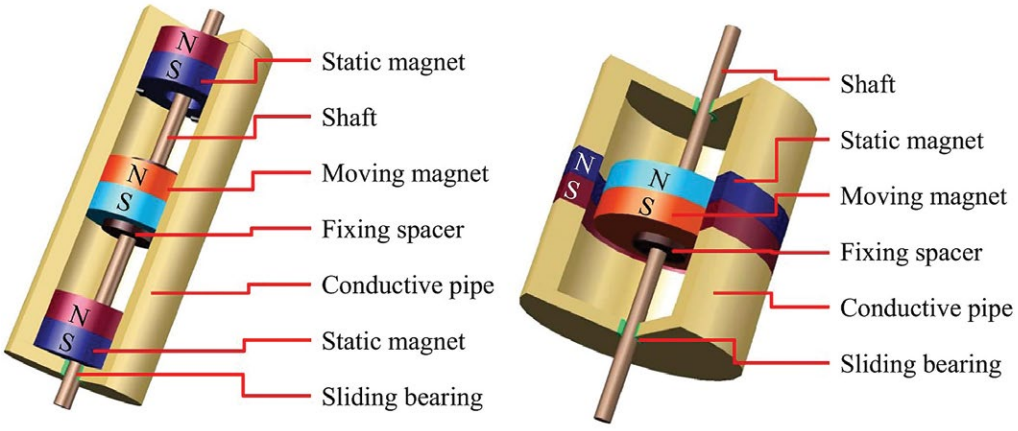
## Novel Magnetic Field-Assisted Mass Polishing of Ultra-Precision Freeform Surfaces

Freeform surfaces have been widely used in various high-value-added applications, such as superfinishing surgical tools and optical moulds. However, current mass finishing technology is inadequate to achieve nanometric surface roughness of freeform surfaces for their functional applications. PolyU's Magnetic Field-Assisted Mass Polishing (MAMP) technology is developed to provide a novel solution for achieving nanometric fast-finishing of a number of freeform components simultaneously. MAMP makes use of a rotational magnetic field applied outside an annular chamber which drives the magnetic abrasives to impinge on and remove material from the workpiece mounted inside the chamber. MAMP has been proven to have high accuracy, high efficiency and cost-effectiveness with successful applications in mass super-finishing of surgical tools and optical moulds.




## Magnetic Negative Stiffness Damper (MNSD)

Magnetic negative stiffness damper (MNSD) provides symmetrical negative stiffness integrated with damping in a compact and simple configuration, comparing this innovation with existing passive negative stiffness device, passive MNSD adopts a completely different magnetic principle. Its mechanical properties can be easily designed by adjusting magnetic properties and arrangement. The passive operation mode of MNSD, together with its compact size and simple design, makes MNSD a promising vibration suppression technique with high performance cost-effectiveness, reliability and practicability. It has a great potential to replace conventional active or semi-active vibration suppression/ isolation systems for various civil, mechanical, and aerospace structures. The performance of MNSD for vibration mitigation was successfully illustrated in bridge stay cables, high-speed train suspensions, vehicle suspensions, vibration isolation tables, etc.




(a) 3D view of Design A (b) 3D view of Design B

Designs A and B exhibit the hardening and softening patterns of negative stiffness, respectively, with increasing displacement. Compared with the existing designs of negative-stiffness systems, the salient features of the proposed MNSD include the following:

(1) symmetrical negative-stiffness behaviour;

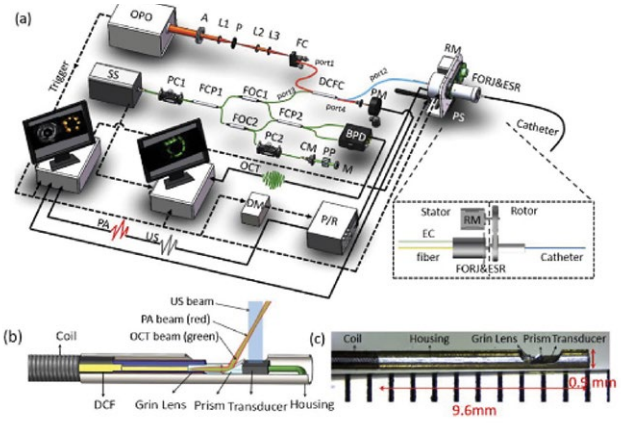
(2) integrated damping characteristic; and

(3) a compact design that can be installed in any direction. The proposed MNSDs have a great potential to replace semi-active or active dampers in diverse vibration suppression or isolation applications.

## Development of Novel Dual-modal Catheter Technology for Intravascular Photoacoustic/Ultrasound Imaging

This technology incorporates high-resolution, high-sensitivity miniature dual-modal catheters using high-frequency piezoelectric materials with special design and micromachining techniques, leading the improvement of the resolution and sensitivity of intravascular photoacoustic/ultrasound imaging. The miniature intravascular catheters employing coaxial optical illumination and ultrasonic detection. The catheter diameter is less than 1 mm. The coaxial configuration is built using a piezoelectric ring-shaped ultrasound transducer with a tiny orifice (about 0.18 mm in diameter) in the centre for the insertion of a multi-mode optical fibre. A rod mirror is employed for reflecting laser and photoacoustic waves for imaging.

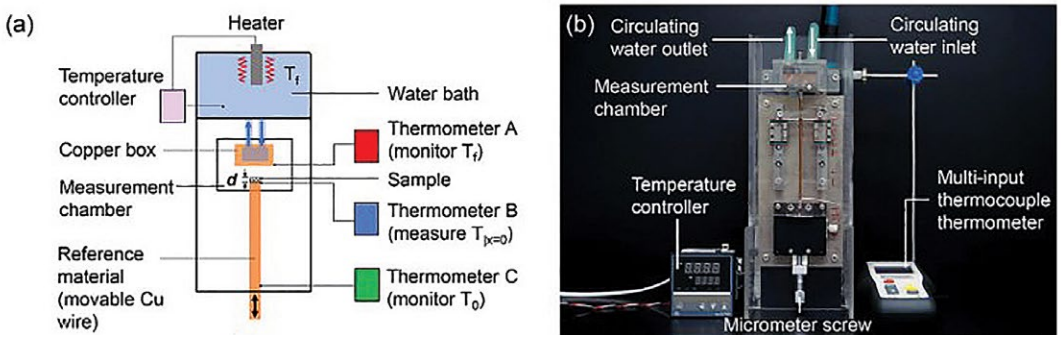
Aiming at novel dual-modal intravascular catheter technology by combining very high-frequency ultrasound and co-axial alignment of optical and acoustic beams, it resolves the limitations of the conventional dual-modal intravascular imaging technology, such as the bulky size for use in tiny vessels, low resolution for not being able to detect thin fibrous caps, low sensitivity, and insufficient imaging sufficiency for clinical translation. The innovation also exhibits the advantages over other state-of-the-arts catheters attributed to its smaller size that can be embedded in the transducer; higher sensitivity by fully covering the imaging window by the area of the transducer enabling all signals reflected from a rod mirror to be received; as well as better imaging depth to detect the targets in a longer range of distance. The innovation also provides an advanced intravascular imaging technology for the detection and identification of vulnerable plaques, which can give rise to new scientific discoveries on its pathological mechanisms as well as the guidance of strategies for early prevention and treatment of the cardiovascular disease.




(a) The multi-spectral intravascular tri-modality (MS-IVTM) system overview, with an inset figure of opto-electric slip ring, (b) the tip of MS-IVTM catheter overview, and (c) photograph.

## Measuring Thermal Conductivity for Submillimetre-Size Materials

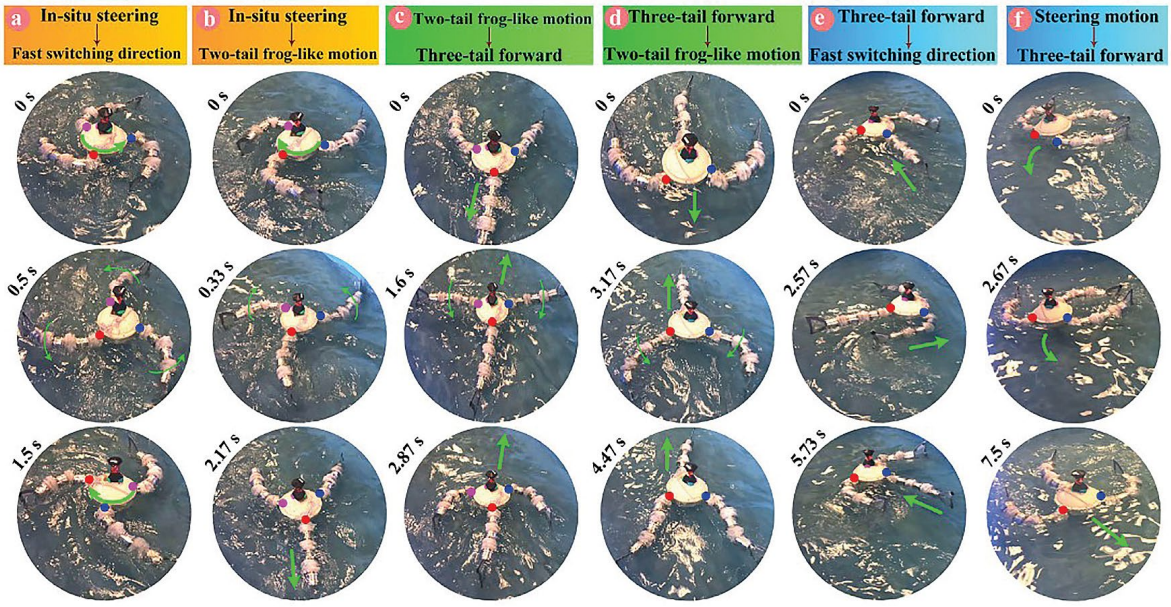
This novel product is capable of measuring the thermal conductivity of the unknown biomaterials of submillimetre size. The measurement results by this method are demonstrated reliable especially for polymeric or organic materials including the RCs of bombardier beetles. The results in this innovation not only help to understand the superior thermal insulation of the RC wall but also offer a facile approach to measuring the thermal conductivity of materials in sub-millimetre size.




(a) Schematic depiction and (b) photo of an apparatus for measuring the thermal conductivity. Here, K-type thermocouple thermometers

# Bio-Inspired Multi-Tail Omni-Directional Underwater Robot – Biomoubot

Conventional biomimetics designs are focused on mimicry of a specific organism or its specific function. Our biomimetic robotic design incorporates combination and coordination of multiple aquatic animals. Biomoubot is a novel omnidirectional underwater robot with multiple tails, combining different advantageous locomotion modes from fish, frog, octopus, fish swarm, and dolphin formation. Swimming locomotion modes including forward motion, steering, sinking, rising and their combinations are realized flexibly. The robot can easily switch between arbitrary locomotion modes to achieve fast changes of swimming directions in 3D space. The robot is first of its kind achieving higher stability, mobility, and manoeuvrability of great potential in working in complex dynamic water environments, and thus presents an alternative and new insight into underwater robotic design and control, focusing on complex water environments.




Demonstration of locomotion modes switching. (a) Fast switching from counter clockwise in-situ steering to clockwise in-situ steering. (b) Switching from in-situ steering to two-tail frog-like forward locomotion. (c) Switching from two-tail frog-like locomotion to three-tail forward locomotion in the opposite direction. (d) Switching from three-tail forward locomotion to two-tail frog-like locomotion in the opposite direction. (e) Fast switching in the three-tail forward locomotion. (f) Switching from steering locomotion to three-tail forward locomotion.

## Omni-Cool-Breath: A Smart Air-Conditioned Mask (TechConnect Innovation Award)

Mask has become a daily necessity for the public, especially since COVID-19 pandemic. However, the use of masks often causes increased temperature and thick humid air. Omni-Cool-Breath is the first automatic temperature-controllable mask that brings revolutionary access to all-day cool breath and thermal comfort under various activities and thermal conditions. It reduces temperature by 12°C and humidity by 65% compared with N95 masks. Based on an innovative miniature thermoelectric unit under low voltage of up to 3V, adaptive to the dynamic thermal conditions and personal activities, the cooling ventilation system enables guided airflow for efficient cooling and easy breathing by a novel wind-regulated tunnel and a dual inverter fan along with the wearer's breathing cycles. This ergonomically designed lightweight mask (180g) uses skin-friendly and biodegradable 3D printing materials that enable the user to enjoy 9 hours of clean air, having a filtration performance 4 times better than a conventional surgical mask. The HEPA filters are placeable, incorporated with rechargeable battery. The transparent anti-fogging front window allows better communication.

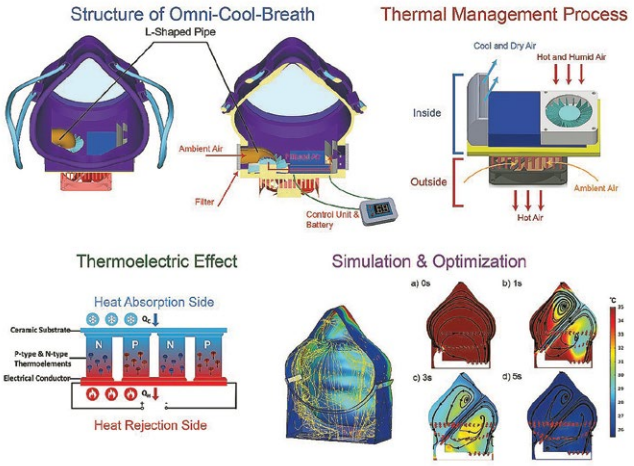
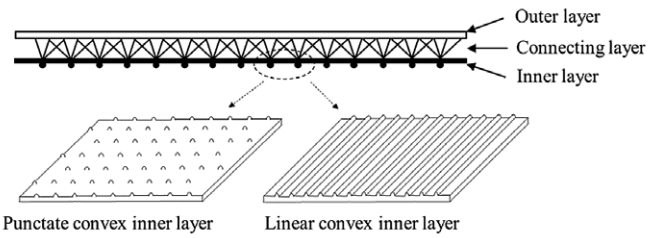



Illustration and design of Omni-Cool-Breath

## Moisture-Absorbing and Sweat-Releasing Multilayer Polylactic Acid (PLA) Fabric and Manufacturing Technology (TechConnect Innovation Award)

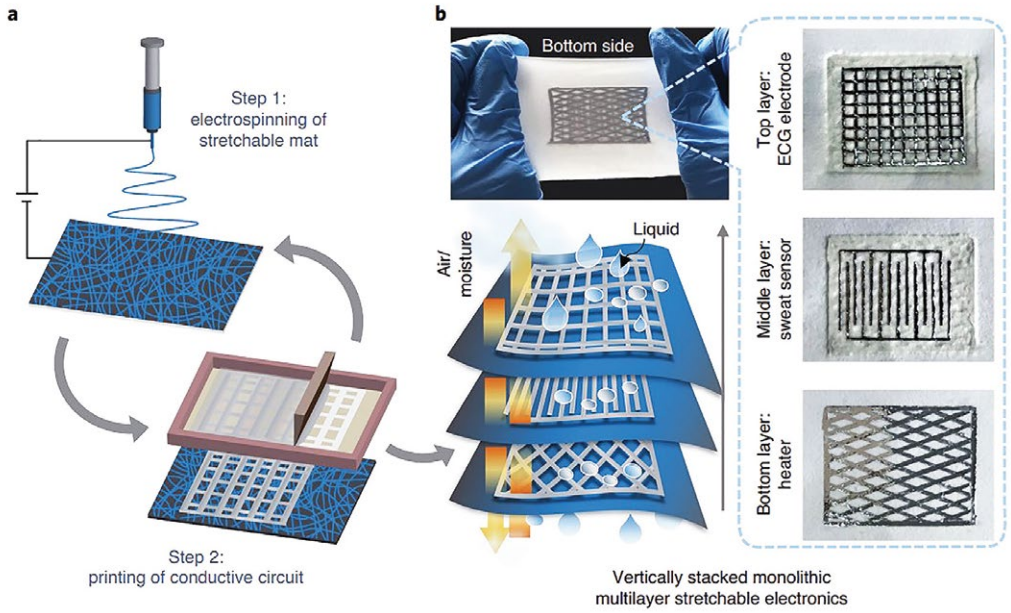
The multilayer polylactic acid (PLA) fabrics is a new type of fabric structure with improved moisture-absorbing and sweat-releasing properties in just one single process by using double weft knitting technology, using biodegradable PLA fibres, it is comprised of an inner layer, a connecting layer and an outer layer. The capillary wicking effect and moisture management of PLA fabrics are improved by using irregular fibre cross-sections and designing special multilayer knitted structures. The fabrication method in this technology is cheaper than the existing ones, the properties are improved only by physical means without any chemical treatment and possesses inherent biological resistance. The PLA fabrics with enhanced moisture-absorbing and sweat-releasing properties can be widely used in the textile industry, i.e., the materials of school uniforms for students, military uniforms for soldiers, sportswear for athletes and young people, underwear for women and so on. This technology could promote the application of PLA material in the textile area.




The knitted structure of multilayer PLA fabric

# Permeable Super Elastic Liquid Metal Fibre Mat Enables Biocompatible and Monolithic Stretchable Electronics

Stretchable liquid fibre metal mat with high permeability and stability: stretchable electronic devices conventionally built with elastomeric thin films show a lack of permeability, which not only impedes wearing comfort and creates skin inflammation over long-term wearing, but also limits the design form. To tackle this problem, an innovative liquid metal fibre mat (LMFM) is developed by simple coating or printing of liquid metal on an electrospun elastomeric fibre mat. Liquid metal hanging among the elastomeric fibres self-organizes into a laterally mesh-like and vertically buckled structure, which simultaneously offers high permeability, stretchability, conductivity and electrical stability. The continuous fabrication of multilayer LMFM enables a versatile and user-friendly platform to develop multi-functional stretchable electronics, including ECG and sweat sensors.



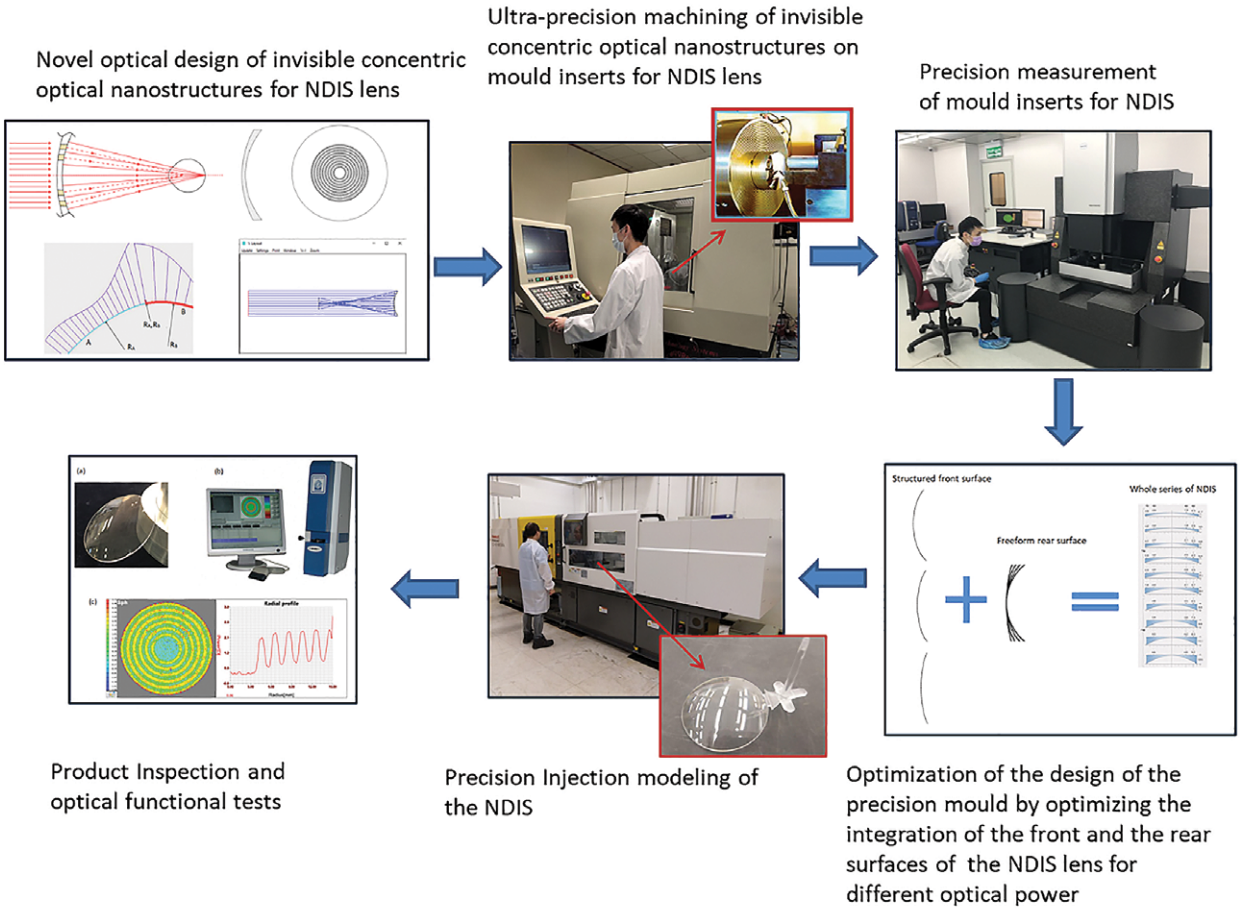

Monolithic stretchable electronics.

a, Schematic illustration showing the fabrication of the vertically stacked monolithic stretchable mat by alternating electrospinning of SBS fibres and stencil printing of EGaIn electrodes.

b, Digital images of a three-layer monolithic stretchable device and the EGaIn electrode structures in each layer. The top layer (next to the skin) is an ECG sensor, the middle layer is a sweat sensor and the bottom layer is an electric heater.

# Novel Optic Design and Precision Manufacturing of a Nanostructured Defocus-Incorporated Spectacle Lens for Human Myopia Control

Human myopia, or short-sightedness is a common eye disorder in modern society, yet existing optical aids and refractive surgeries does not deal with the root cause of the disorders. PolyU developed a novel optic design of seamless concentric optical nanostructures and proprietary ultra-precision manufacturing and testing technology of the nanostructured defocus-incorporated spectacle (NDIS) lens for myopia control. The NDIS lens has been developed based on the emmetropization feedback mechanism of human eyes to control myopia by producing a primary image on the retina and a secondary image in front of or at the back of the retina to generate a myopic defocus which can effectively inhibit elongation of the eyeball to slow the myopia progression of school children. The NDIS lens addresses the market need for subversive improvement of the existing treatment of myopia for school children's eye health.

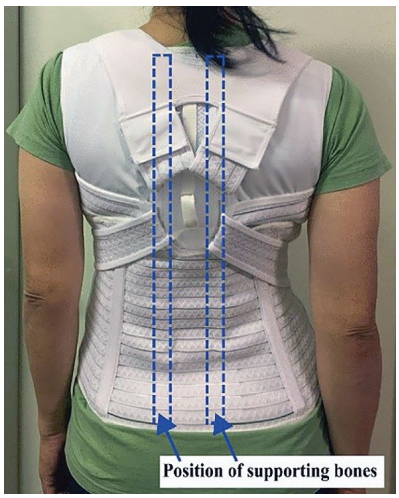



NDIS manufacturing process

## Posture Training Bodywear for Older Adults with Degenerative Scoliosis

Adult degenerative scoliosis (ADS) is a degenerative condition found in the ageing population without any history of spinal deformity. Patients with ADS usually suffer from progressive lower back pain, deformity, and symptoms of sagittal imbalance. Bracing being the most typical non-invasive treatment recommended for ADS, can only help with temporary pain relief and supports body alignment through passive corrective forces. Extended periods of bracing can even cause deconditioning of the paraspinal muscles and further worsening of the symptoms. Other side-effects like muscle atrophy, pressure marks, skin irritation, breathing issues and inconvenience for patients with limited mobility are also associated with bracing.

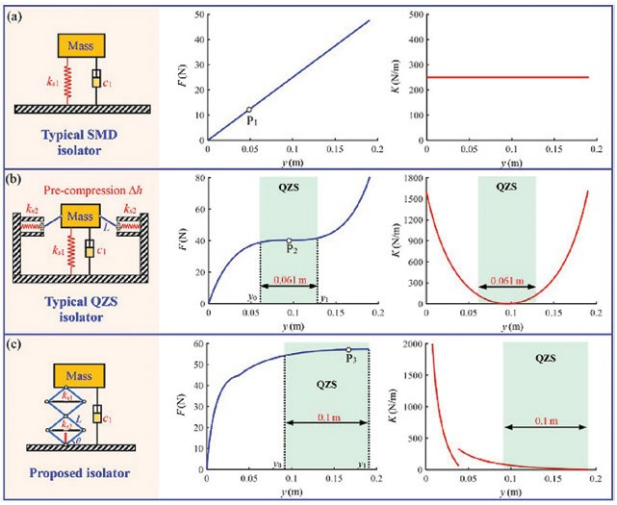
To address the problems associated with bracing, a notification sensor-based active training bodywear made of rigid, semi-rigid and flexible garment materials that incorporates both passive and active corrective forces with a more age-friendly design is developed, it can significantly help maintain the level of bodily function of patients while minimizing the symptom progression of ADS, support body alignment and manage pain, as well as improving the current problems of brace-wearing experiences through the posture training bodywear. A specially-engineered pulley system is also incorporated, which can better address the needs of older patients and provide them with better bodywear experience.




Back view of donned posture training bracewear

## High Performance X-shaped Passive Control Anti-Vibration Structure (TechConnect Innovation Award)

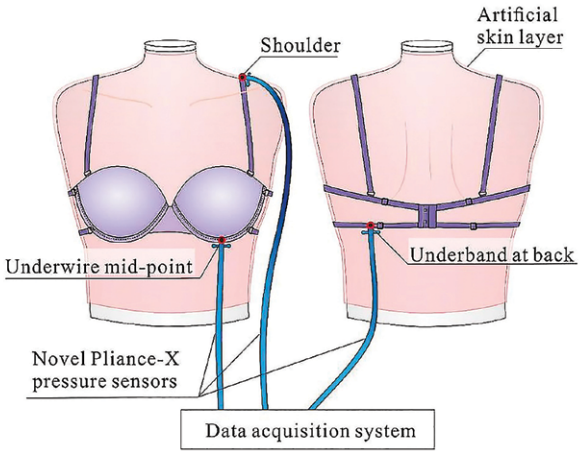
The X-shaped bio-inspired structures are novel designs of passive vibration isolation systems by using only linear spring and damping components to achieve superior nonlinear vibration isolation. The technology provides excellent passive quasi-zero stiffness of high loading capacity, and nonlinear high damping at resonant frequencies but low at other frequencies, without unstable nonlinear equilibrium. The structure can provide flexible and adjustable stiffness up to zero and adjustable nonlinear damping characteristic. The stiffness is decreasing with the increase of compression or extension of the structure, it is different from existing spring systems which have higher stiffness subject to more compression or extension. The technology is easy to implement and flexible in usage of low cost. The systems can be with n-layers of X-shaped structures to suit different applications, such as leg/joint design of robots, limb-like structured suspension for mobile robots with track, protection of high-precision machinery, space launch and on-orbit applications.




Schematic diagrams, force-displacement and stiffness curves of
(a) a typical linear string mass damper (SMD) isolator,
(b) an existing typical quasi-zero-stiffness (QZS) isolator and
(c) the proposed isolator under the novel spring arrangement based on X-shaped anti-vibration structure with tuneable contact (NXSC)-I mechanism.

## A Soft Manikin System for Evaluating Dynamic Breast Movement and Pressure Sensation for Bra Design Optimisation

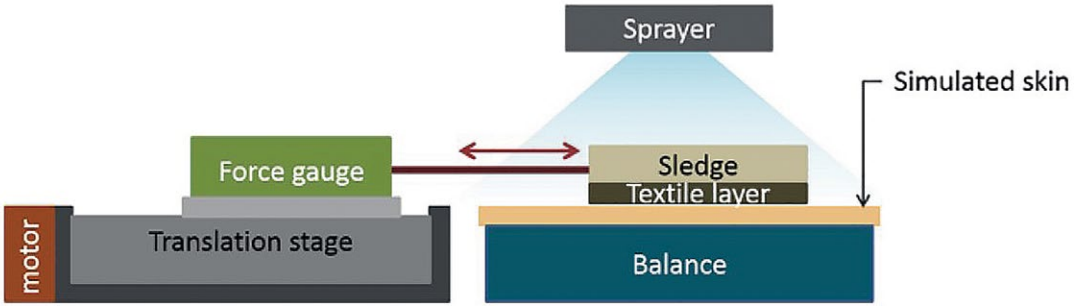
A novel soft manikin system for evaluating bras: to date, the characterization of bra support and contact pressure mainly relies on human wearer trials where reproducible testing is difficult to achieve and experienced technicians are always required. Through a scientific analysis of the bio-mechanical interface between the human body and the bra, a novel soft manikin system is developed for the evaluation of bras – taking the level of breast support, displacement and wearing comfort during dynamic body movements and physical activities into consideration. Through this innovation, the most beneficial bra design features for different end-uses can be objectively identified.




Bra-manikin pressure measured locations including mid-point of underwire, shoulder and underband at the back

## Friction Tester Characterizing the Stickiness Property of Textiles under Wet Skin Surface

This innovation, namely Textile Friction Tester (TFT) is capable of testing clothing comfort and characterizing the frictional property of textiles under wet skin surface. Wet clothing scenario is simulated by first spraying predetermined amount of water onto the simulated skin layer, then dragging the sample on top of TFT at a constant speed. A force gauge connecting to the sample was used to measure the force required to drag on a wet skin surface. 5 types of fabrics with varying constructions and material has been tested and the results revealed that TFT is highly sensitive and reproducible in differentiating these fabrics and it suggests that frictional properties of fabrics are skin wetness dependent. The uniqueness and advantages of TFT include: (a) capable of measuring frictional properties under different moisture levels (b) versatile in terms of the type of fabrics tested (c) comprehensive description on stickiness properties of samples against skin (d) simple setup with high system accuracy (e) short testing and fabric preparation time (f) affordable cost (g) useful for product selection especially for sportswear, hygiene products or medical textiles application.




Construction of Textile Friction Tester

## 3D Intelligent Dynamic Fabric Tension-Pressure Testing System

The fabric tension, pressure, and their interactions are the most important mechanical properties that significantly affect pressure function, biomechanical efficacy, treatment outcome and dynamic wearing comfort. Yet up till now, no technology and equipment are available in the market to directly test such dynamic tension-pressure properties of the elastic fabric. The new bionic 3D-IDFTP technology developed by PolyU is a breakthrough in the field of textile fabric measurements. Not only can it automatically and synchronically test mechanical tension and pressure properties of elastic fabrics with a controlled stretching ratio and velocity in both 2D and 3D scales, it can also intelligently analyse and display strain-stress-pressure curves and their interactive relationships in real-time. This new technology can be applied in fabric measurement and testing in textile manufacturing factories, experimental labs, standard agencies, and research organizations for quality control, performance assessment, material mechanical studies, and standard development related to functional textiles and garments.

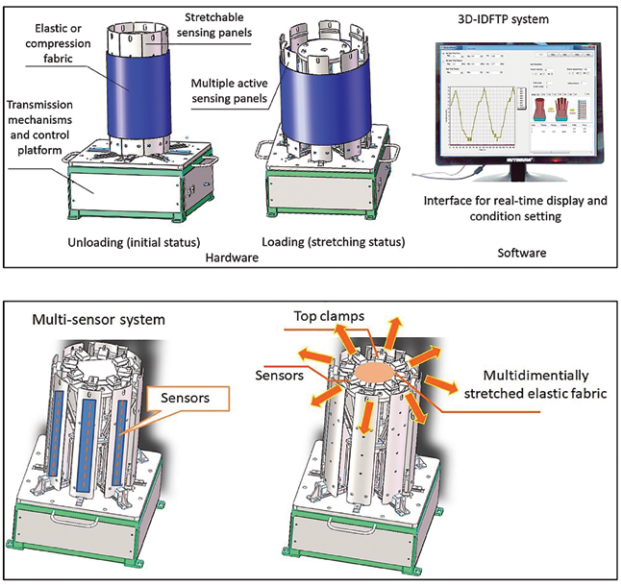
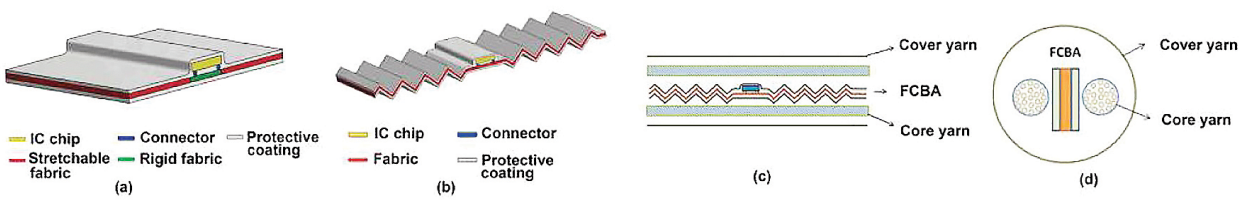



Illustration of bionic 3D-IDFTP technology

## Fine, Soft and Washable Electronic Yarns Made by Scalable Manufacturing Processes

These innovative electronic yarns are the worlds' finest for electronic knitting or embroidery with a diameter of less than 1 mm. It is very soft with bending rigidity only a tenth of the existing products of the same diameter. The electronic yarn can be applied as part of textile fabrics and form many possible shapes, and has wide applications including medical devices, sports, automotive accessory, fashion, art performance, military and aerospace.

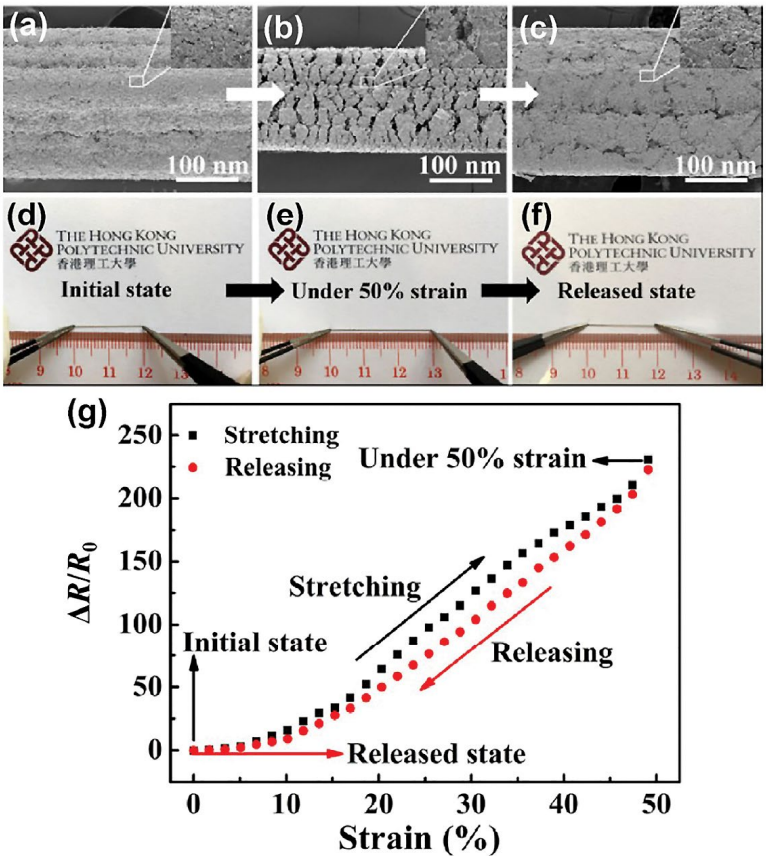



(A) and (B) Two types of schematic Fiber-based Circuit Board Architecture (FCBA) structure;
(C) Composite electronic yarn;
(D) Cross-section of the composite yarn.

# Wearable Strain Sensing Textiles for Human Motion Monitoring

There is a rapidly growing demand for flexible and wearable strain sensors to monitor human motions and physiological conditions. However, most reported sensors for wearable electronics are usually fabricated in two-dimensional strip configurations, which cannot be properly integrated into textile structures and thus greatly degrade intrinsic properties and aesthetics of clothing.

At PolyU, a new one-dimensional weavable strain sensing yarn with unique multilayer structure is designed by an easily manipulated protocol. The strain sensor not only exhibits excellent sensing performance but also possesses good weavability. Consequently, such yarn sensor has been directly integrated into various textile structures by using existing textile technologies for fabricating sensing textiles. The sensing textiles demonstrate their strong capability for real-time monitoring of human motions. This technology can be applied in clinical and healthcare biomechanics, clothing for outdoor activities and athletic training, functional clothing for the measurement of strain/pressure distribution and garment design and garment fitting evaluation.



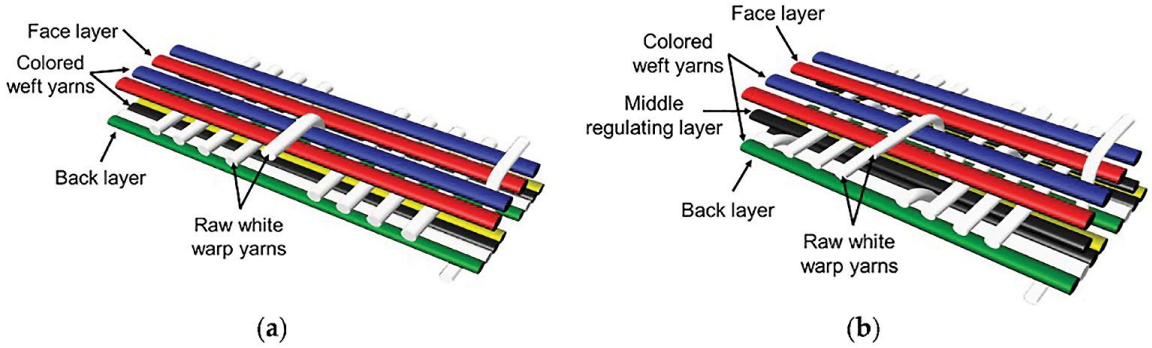

SEM images of as-fabricated PDMS/AgNPs/GMs/PU coaxial-structured strain sensing yarn under (a) no applied strain, (b) 50% applied strain, and (c) unloaded strain. Corresponding optical microscopy photos of PDMS/AgNPs/GMs/PU coaxial structured strain sensing yarn under (d) no applied strain, (e) 50% applied strain, and (f) unloaded strain, and (g) resistance–strain relationships of PDMS/AgNPs/GMs/PU coaxial-structured strain sensing yarn under stretch/release cycles and 50% applied strain.

## Enhance Technology that Simplifies Production for Graphic Fabrics

Colourful and graphic fabric produced by using coloured-yarns represents high technology and high value-added product are widely used for fashion, home furnishings and decorations. However, the existing manufacturing methods for colourful and graphic fabric by using both multi-coloured warp and weft yarns include a complex yarn preparation process results in the great increase of production cost and the lowering of the flexibility of fabric design and production.

A novel manufacturing technology based on a raw-white-warp and multi-coloured weft approach is designed to offer a new method that is feasible, cost-effective and sustainable for fabricating colourful and graphic fabric, including the optimal weft colour combinations for full-colour creation and presentation of new colour / weave databases for creating colours and figures.

Potential application areas for this innovation include high-end / high-quality fashion, home furnishing and decoration industries.




Weft-faced, weft-backed structures: (a) structure without regulating layer; (b) structure with regulating layer.

## Co-catalyst System Flame Retardant Treatment for Cotton (TechConnect Innovation Award)

Fabrics made from cellulosic fibres, such as cotton and linen will burn easily with a high flame velocity. Many flame retardant (FR) agents and methods of application have been developed in attempts to produce FR textile materials. However, the FR agents are not efficiently fixed to the cotton fibres unless they are used in combination with a resin and catalyst. Now, the use of co-catalyst can effectively enhance the flame-retardant effect and minimise the side effects of flame-retardant treatment. The finishing formulation (recipe) proposed in this invention is applied to cotton fabric by conventional pad–dry–cure finishing techniques. With the use of co-catalyst system in the flame-retardant treatment, it can reduce the curing temperature and time used for flame retardant treatment, and retain good flame-retardant property of cotton fabric even at a lower curing temperature and shorter curing time. It can also minimize the reduction in tearing strength and whiteness of cotton fabric after flame retardant treatment.

## Durable Inorganic Metal Oxide Layer Achieved Using Seeded-Sonochemical Deposition Method (TechConnect Innovation Award)

A novel, facile and less expensive metal oxide deposition method in textile industry: currently known techniques for over-coating inorganic metal oxide layer requires high temperature, low pressure and specialized gaseous environments procedures. Our innovation using seeded-sonochemical deposition method makes use of the small seeding layers to direct a more durable overcoating inorganic metal oxide layer, which is faster and can be done in ambient environment. As a result, pure products can be obtained in high quality with cheaper and more efficient process. Functional clothing and glazing apparel are some areas that can utilize this method.

## Non-aqueous Wool Fibre Dyeing Process using Reverse Micellar Approach

In textile industry, reactive dyeing using nanoscale dye carrier in non-aqueous solvent mostly has well dispersibility, low viscosity and high diffusion into wool fabric matrix properties can result in shorter dyeing periods in comparison with the conventional water dyeing process. The working temperature of non-aqueous dyeing is 88°C, which is 10°C lower than in conventional water-dyeing process in terms of energy saving aspect. The obtained colour strength in terms of K/S sum value is better than that in conventional aqueous dyeing. Dyeability of wool fibre with reactive dye from the reverse micellar solution is improved without incorporation of textile auxiliaries such as electrolytes and chemicals like acetic acid or sodium bicarbonate for pH adjustment.


Visual image of dyed wool knitted fabrics in; (a) water, (b) octane, and (c) nonane

# Research Labs, Institutes and Centres

## State Key Laboratories

- State Key Laboratory of Chemical Biology and Drug Discovery (The Hong Kong Polytechnic University)
- State Key Laboratory of Ultra-precision Machining Technology (The Hong Kong Polytechnic University)

## Hong Kong Branches of Chinese National Engineering Research Centres

- Hong Kong Branch of National Engineering Research Centre for Steel Construction
- Hong Kong Branch of National Rail Transit Electrification and Automation Engineering Technology Research Centre

## Chinese Academy of Sciences - PolyU Joint Laboratories

- Joint Laboratory for Aerosol and Environment
- CAS AMSS-PolyU Joint Laboratory of Applied Mathematics
- CAS GIG-PolyU Joint Laboratory of the Guangdong-Hong Kong-Macao Greater Bay Area for the Environment

## PolyU Academy for Interdisciplinary Research (PAIR)

- Mental Health Research Centre
- Otto Poon Charitable Foundation Research Institute for Smart Energy
- Otto Poon Charitable Foundation Smart Cities Research Institute
- Photonics Research Institute
- Research Centre for Chinese Medicine Innovation
- Research Centre for Deep Space Explorations
- Research Centre for Resources Engineering towards Carbon Neutrality
- Research Centre for SHARP Vision
- Research Institute for Advanced Manufacturing
- Research Institute for Artificial Intelligence of Things
- Research Institute for Future Food
- Research Institute for Intelligent Wearable Systems
- Research Institute for Land and Space
- Research Institute for Smart Ageing
- Research Institute for Sustainable Urban Development

## InnoHK Research Centres

- Centre for Advances in Reliability and Safety (CAiRS)
- Centre for Eye and Vision Research (CEVR)
- Laboratory for Artificial Intelligence in Design (AiDLab)

## University Research Facilities

- Centralised Animal Facilities
- University Research Facility in 3D Printing
- University Research Facility in Behavioral and Systems Neuroscience
- University Research Facility in Big Data Analytics
- University Research Facility in Chemical and Environmental Analysis
- University Research Facility in Life Sciences
- University Research Facility in Materials Characterization and Device Fabrication

## Other Faculty and Department Based Research Centres

- Faculty of Applied Science and Textiles
  - Food Safety and Technology Research Centre
  - Lo Ka Chung Research Centre for Natural Anti-Cancer Drug Development
  - Research Centre for Smart Wearable Technology
  - The PolyU-SDU Joint Research Center on Financial Mathematics
- Faculty of Business
  - Logistics Research Centre
  - Shipping Research Centre
- Faculty of Construction and Environment
  - Research Centre for Environmental Technology and Management
  - Research Centre for Fire Safety Engineering
  - Research Centre for Geo-Information Science and Technology
  - Research Centre for Sustainable Infrastructure Development
  - Research Centre for Urban Hazards Mitigation
  - The Hong Kong Polytechnic University – Wuhan University Partner GNSS Research Centre
- Faculty of Engineering
  - Advanced Manufacturing Technology Research Centre
  - Biometrics Research and Innovation Centre
  - Knowledge Management and Innovation Research Centre
  - Power Electronics Research Centre
  - Research Centre for Fluid-Structure Interactions
  - Research Centre of Advanced Materials for Batteries
  - Research Centre on Data Science and Artificial Intelligence
- Faculty of Health and Social Sciences
  - Centre for Myopia Research
  - Peking University-The Hong Kong Polytechnic University China Social Work Research Centre
  - Public Policy Research Centre for Innovation and Technology
- Others
  - Aviation Services Research Centre
  - Industrial Centre

# Science and Engineering-Related Departments

At PolyU, we embrace collaborative research and development during our innovation process. Whatever your unmet needs are, we have a team of experts ready to help you tackle your challenges.

## Faculty of Applied Science and Textiles

- Department of Applied Biology and Chemical Technology
- Department of Applied Mathematics
- Department of Applied Physics
- Institute of Textiles and Clothing

## Faculty of Construction and Environment

- Department of Building Environment and Energy Engineering
- Department of Building and Real Estate
- Department of Civil and Environmental Engineering
- Department of Land Surveying and Geo-informatics

## School of Design

## Faculty of Engineering

- Department of Aeronautical and Aviation Engineering
- Department of Biomedical Engineering
- Department of Computing
- Department of Electrical Engineering
- Department of Electronic and Information Engineering
- Department of Industrial and Systems Engineering
- Department of Mechanical Engineering

## Faculty of Health and Social Sciences

- Department of Health Technology and Informatics
- Department of Rehabilitation Sciences
- School of Nursing
- School of Optometry

## Contact RIO Today

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